PRACTICAL ENGINEER

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POWER PLANT IN WOODMEN OF THE WORLD BLDG.

An Isolated Plant Furnishing All Mechanical, Electrical and Temperature Needs of a Building. Storage Battery a Distinctive Feature

IT WOULD SEEM STRANGE that Woodmen should overstep the bounds of their profession and erect a building almost completely without wood, but that is what has happened in Omaha, and the Woodmen of the World have one of the most up-to-date office buildings in the country. Eighteen stories of steel and brick structure tower far above all other buildings in the neighborhood of 14th and Farnam Streets, and at night shed beams of light to all parts of the city from the observation roof and would seem to challenge all light producers in the city to do better if they can. Such a challenge as that is broad and invites investigation.

So we started with the boiler room, after taking a casual glance through the building, to learn the class of service which would be demanded from the plant. Omaha has recently put into effect an ordinance prohibiting smoke from power plants, that is, a plant which smokes more than 9 min. total during an hour is subject to a fine and we find in this plant, which is compelled to use Iowa coal, equipment which is designed to accomplish smokeless combustion.

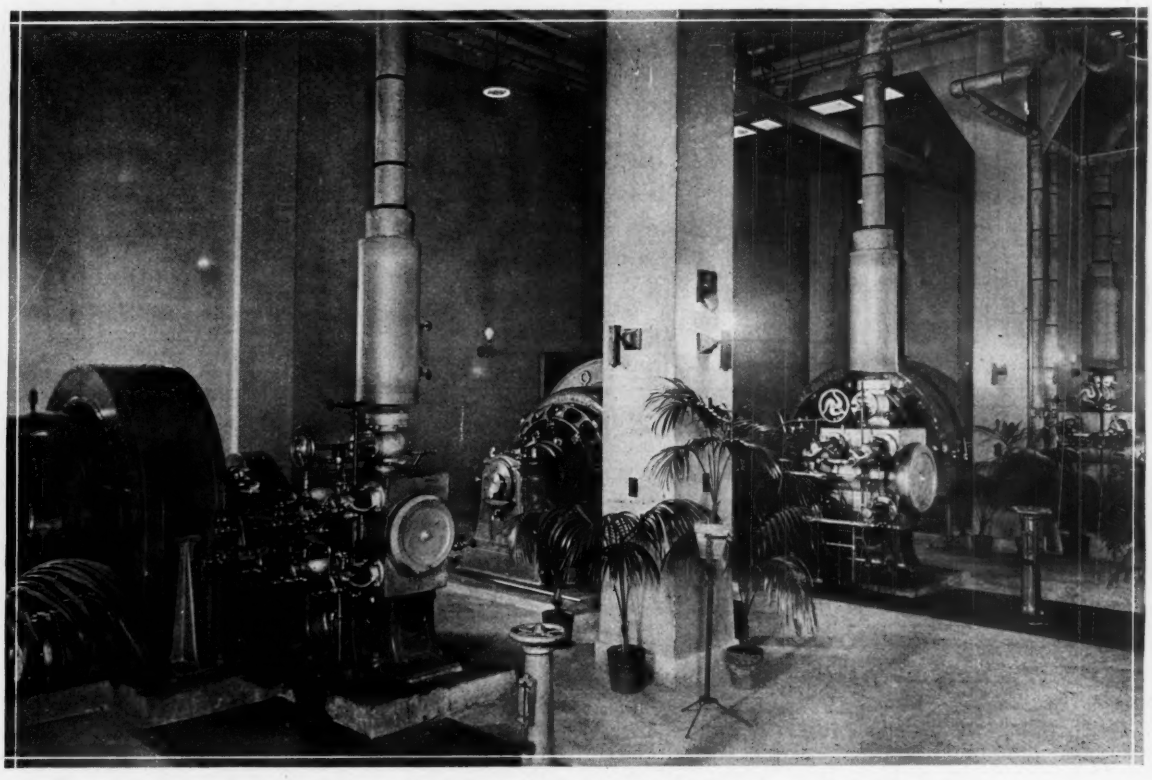


FIG. 1. GENERATING UNITS IN THE WOODMEN OF THE WORLD BUILDING

Three Lyons boilers, which are combination water tube and fire tube construction, constitute the steam generating equipment. Each has a capacity of 175 hp., with 1750 sq. ft. of heating surface or 10 sq. ft. per boiler horsepower rating. The pressure rating is 150 lb. per sq. in., although the boilers are operated at 135 lb. Hand fired, Dutch oven furnaces, fitted with rocking grates, are placed under the boilers, these being furnished by the Chicago Tile Arch Co., of Chicago. Boiler equipment consists of Williams high and low water alarm columns, pop safety valve, Marsh illuminated dial steam gage, Diamond Power Specialty Co. flue blower, Ellison differential draft gage graduated to 0.01 in., 2 angle blowoff valves, made by the Yarnell Waring Co., backed by cocks, and a Fisher governor for controlling feed water.

For ordinary operation, 1 boiler-feed pump takes care of the battery; this is a Canton-Hughes duplex pump, 8 by 4½ by 10 in., and takes the water from the heater at about 212 deg. F., delivering it through a Venturi water meter to the boilers. There is also an emergency line entirely separate from that ordinarily used through which a Platt Iron Works Co. triplex pump feeds the boilers. This pump is single acting, 4½ by 6 in., and run by a 5-hp. Crocker-Wheeler motor.

Blowing down is done into a blowoff tank which overflows into another tank and then to the sump pit; these tanks are both vented to the roof.

To elevate the drainage of the power plant and basement from the sump to the sewer a Yeoman's duplex electric ejector is employed, while for emergency use there are 2 pumps made by the Nye Specialty & Machine Co., which may be employed. One of these is located in the boiler room and pumps from the sump, while the other is in the engine room and is used to drain the exhaust pipe tunnel should it become flooded.

Coal is dumped from wagons in the alley to 2 bunkers directly in front of the boilers, and fed by hand to the furnaces, the capacity of each bunker being 4 car loads. Ashes are carried by a motor-driven bucket elevator to wagons in the alley.

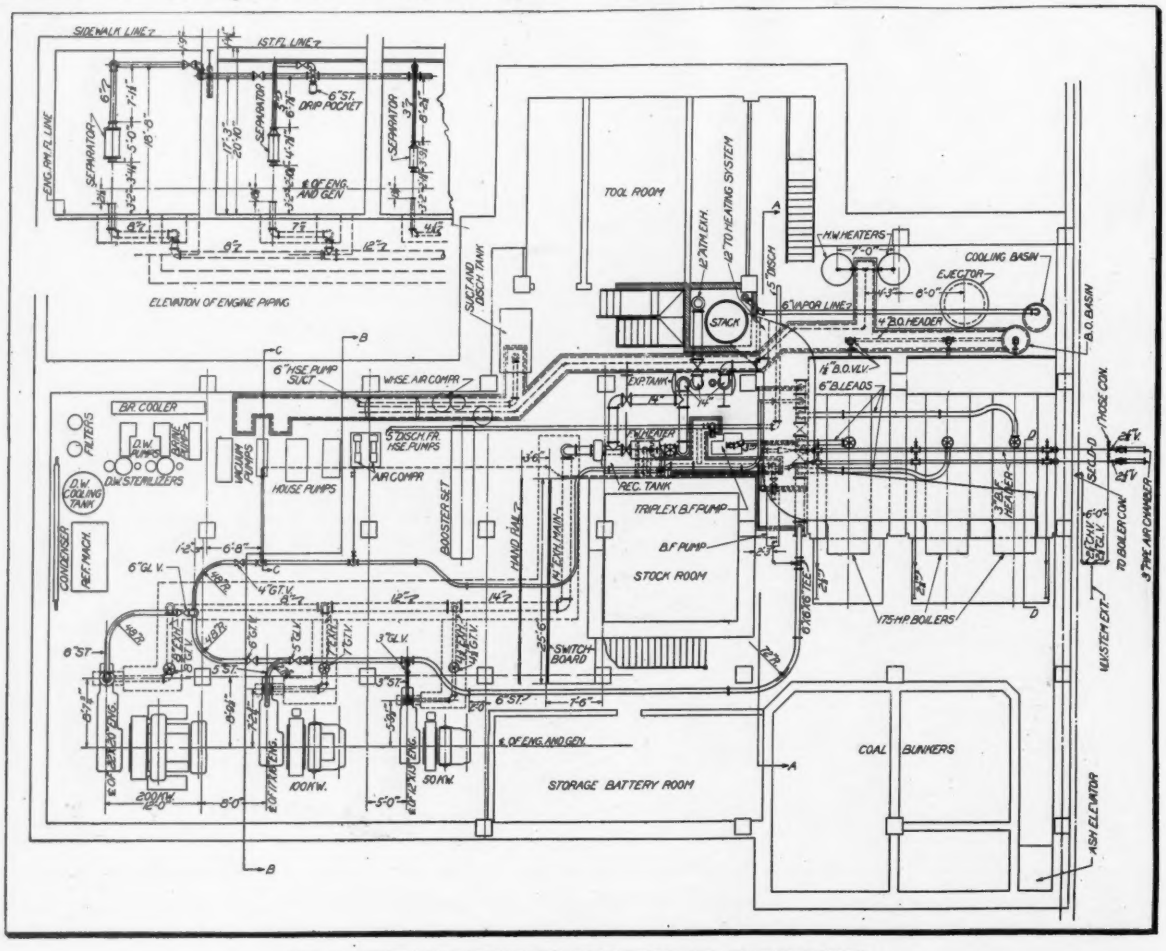


FIG. 2. GENERAL LAY-OUT OF THE BOILER AND ENGINE ROOMS

The flue gases are conducted to the stack by a common breeching made of 3/16-in. tank steel, 55 by 72 in., covered with 85 per cent magnesia blocks bound with duck and painted. Excellent draft is secured with the stack, which is 280 ft. high and 6 ft. 4 in. diameter.

Draft is automatically regulated by a damper in the main breeching under the control of a Spencer damper regulator, in addition to which there is a hand operated damper in the breeching of each boiler.

Engine Room

FOLLOWING now the course of the steam from the boilers, we are led to the engine room. Steam is conducted through angle stop valves and pipes with

long radius bends to a common header, which is provided with suitable drains, and from this a loop of piping takes steam to the main units and pumps.

Generating units consist of 3 Fleming Harrisburg engines, direct connected to Crocker-Wheeler generators. The largest unit is rated at 300 hp., having a cylinder 22 by 20 in., and runs a 200-kw. generator at 150 r.p.m. The generator is wound for the 3-wire system, 230-115 volts, 870 amp., being capable of carrying an unbalanced load, giving 218 amp. on the neutral wire.

The second unit in size is rated at 150 hp., having a cylinder 17 by 16 in., and runs a 100-kw. generator at 170 r.p.m.; the voltage is the same as for the large unit, and the winding will take care of 430 amp. and 109 amp. in the neutral.

An 80-hp. engine, 12 by 13-in. cylinder, of the same type is the smallest unit, and drives a 50-kw. generator at 225 r.p.m.; the winding is proportioned to care for 217 amp. in the main leads and 54 amp. in the neutral.

These engines are equipped with nonreleasing Corliss valve gear which is operated by 2 eccentrics on the main shaft, and the steam valves are under the control of the flywheel governor which makes the engines noiseless in operation and the economy of steam is exceedingly good. The specifications under which the 150-hp. engine was built are similar to those for the other engines, and a summary of the contract requirements and the result of the test made of the engine prior to installation are given below;

Steam pressure 110 lb. Revolutions per Minute 170. Noncondensing. Clearance Head End 6 per cent. Clearance Crank End 5.52 per cent.

Load	25%	50%	75%	100%	125%
Specified requirements.	33.3	25.3	23.8	24.3	25.3
Dry steam by test	29.8	23.64	22.86	23.06	23.28
I. hp.	39.95	77.91	114.375	146.169	194.69

Regulation

Spec. Requirements—Regulation Guarantee—No load to full load 1¼ per cent.

Spec. Requirements—Instantaneous Variation—No load to full load 1¼ per cent.

Speed of engine by test—No load—173 r.p.m.
" " " " " ¼ " 172 r.p.m.
" " " " " ½ " 172 r.p.m.
" " " " " ¾ " 171 r.p.m.
" " " " " Full " 171 r.p.m.

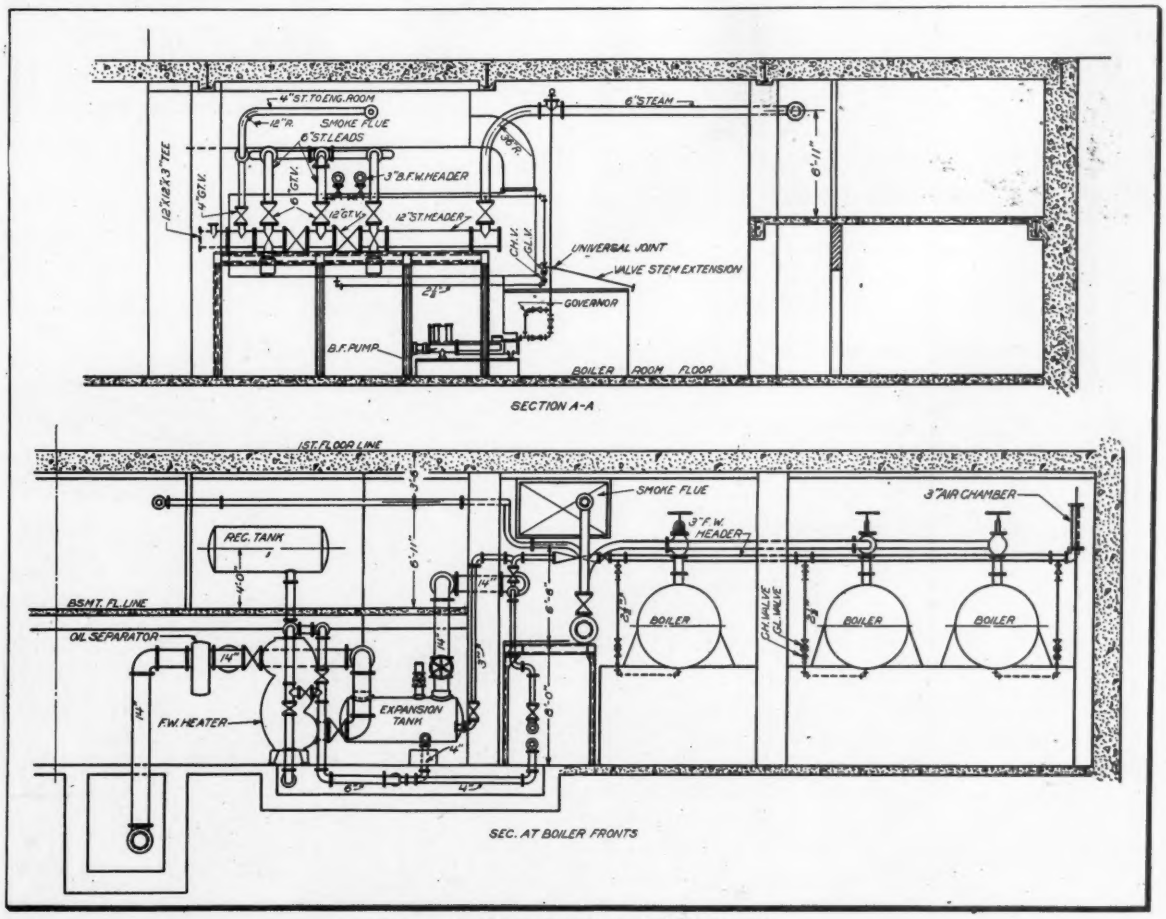


FIG. 3. CROSS SECTIONS OF STEAM PIPING

Speed of engine by test—1¼ load—169.857 r.p.m.

Instantaneous Variation—No load to full load—2 r.p.m.

From the curve plotted of the results of this test, shown in Fig. 5, it will be noted the steam economy over a wide range of load is exceedingly constant, the variation being scarcely a pound from ½ to 1¼ load.

The steam connections to these engines are 6, 5 and 4-in. respectively, there being a Direct steam separator just above the cylinder of each engine. The exhaust connections are 8, 7 and 4½-in. respectively, and, during winter months, take the exhaust to the

heating system under about 1 lb. back pressure. During the warm seasons the exhaust is direct to atmosphere through a relief valve and a 12-in. pipe in the stack shaft.

Refrigerating System

FOR the comfort of tenants and the needs of the kitchens in the building, the engineer is called upon to furnish cold drinking water and maintain a low

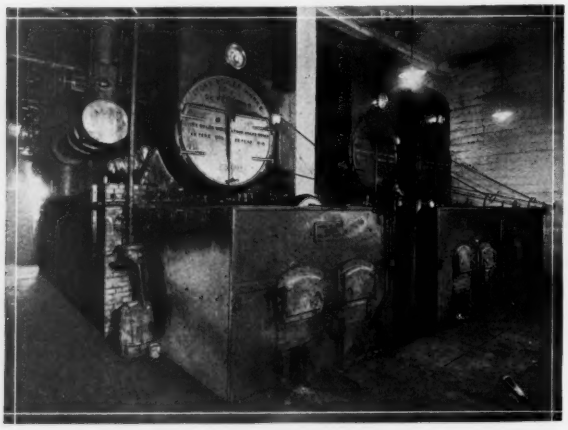


FIG. 4. STEAM GENERATING EQUIPMENT

temperature in the cooling boxes. Throughout the entire building, at most convenient places, are located drinking water fountains which are furnished with water at 40 to 50 deg. The faucets are connected by as short and direct pipes as possible to the cold water circulating pipe, through which the water is kept flowing by means of a pump in the engine room. Water furnished for drinking purposes is thoroughly filtered and sterilized before it is cooled.

In the basement of the building is a cafeteria and on the top floor the kitchen of the Commercial Club, the cooling boxes in these kitchens are provided with

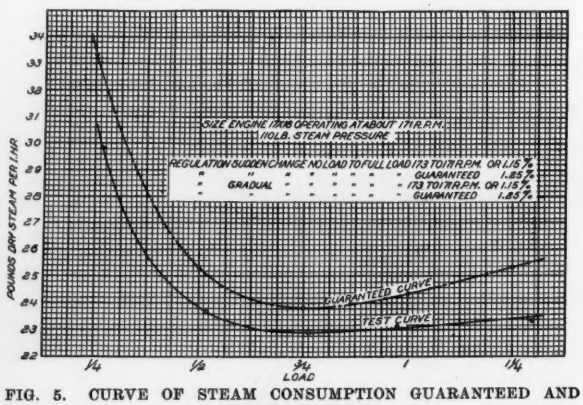


FIG. 5. CURVE OF STEAM CONSUMPTION GUARANTEED AND RESULTS OF TEST

coils through which brine, at a temperature of 16 deg. F., is circulated. All the refrigerating piping is thoroughly insulated with cork covering in order to maintain the temperature as low as possible.

To supply these demands for refrigeration a 5-ton

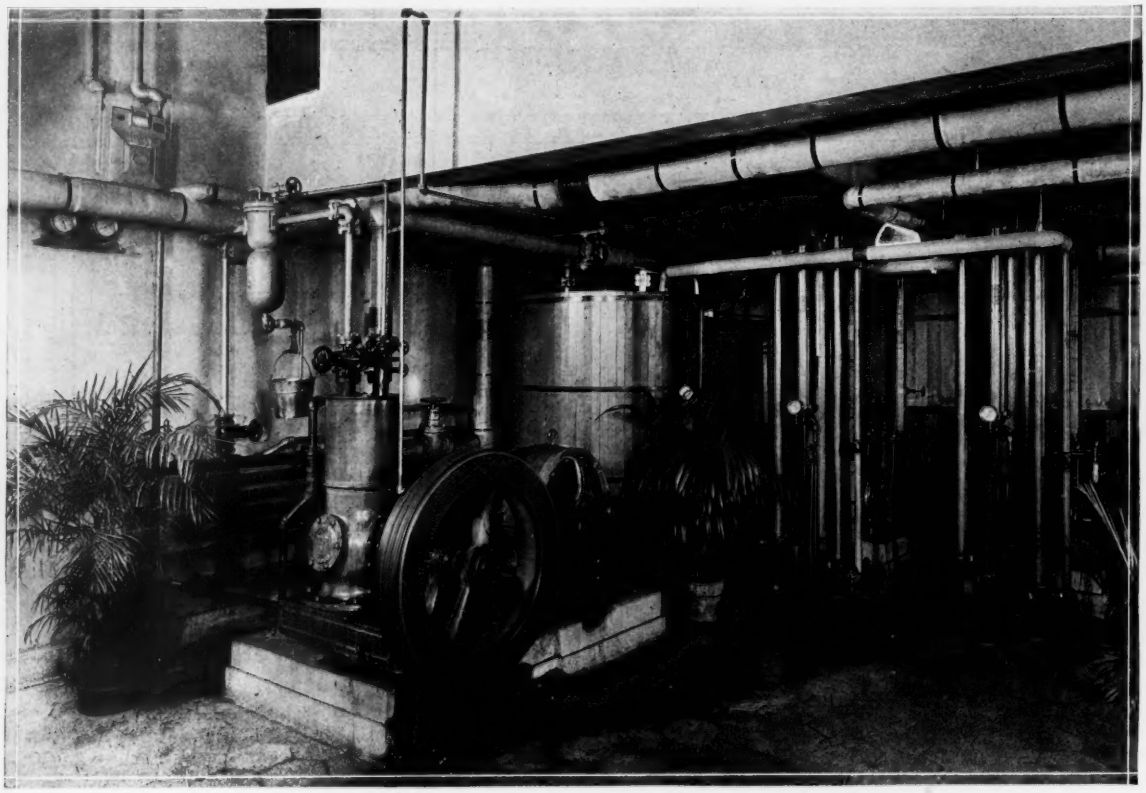


FIG. 6. REFRIGERATING APPARATUS IN ENGINE ROOM

outfit was furnished by the Baker Ice Machine Co., and is shown in Fig. 6. The compressor is driven by a 15-hp. Crocker-Wheeler motor. Two Forbes water

sterilizers and 2 International filters are used in purifying the drinking water.

There are 2 drinking water pumps, one of these being kept as a reserve; both of these are 2¼ by 4-in. Platt Iron Works Co. triplex pumps driven by 3-hp. motors. The brine circulating pump is of the centrifugal type direct connected to a 6-hp. motor and runs at a speed of 1050 r.p.m.

Heating System

AS previously stated, the exhaust steam from the engines and all auxiliaries goes through a Cochrane oil separator to the heating system. In a bypass, however, from the exhaust main, is connected a National open type feed-water heater, with the valves so arranged that any portion of the exhaust steam may be passed through the heater.

The vacuum heating system employed was designed by the National Heat and Regulator Company and piping is done on the downward supply plan, 2 main headers in the pent house supplying the steam to the various drops which are connected to the radiators, these having but one connection. Temperature in the various rooms is regulated by the National thermostatic system of control. Two simplex Marsh air compressors supply air at 15 lb. pressure to operate the thermostatic system.

Ordinarily the engines exhaust against a pressure of less than a pound, this being maintained by a back-pressure valve, but during the summer months the exhaust is carried to the roof against atmospheric pressure. The returns from the heating system are led to an expansion tank in the engine room and used for feeding the boiler.

Two pumps are provided for maintaining the vacuum on the return heating pipes, one of these being for emergency use. The main pump is driven by a 3-hp. motor, the dimensions of the cylinder being 10 by 8 in. The other vacuum pump is a Burnham simplex, 8 by 10 by 12, and is equipped with a Fisher governor. The pumps are shown in the foreground of Fig. 7. These pumps discharge the water to a supply tank from which it is fed as needed to the boilers.

Heating of the main entrance is done by the indirect method, the coils being located in the fan room in the basement, and the air is blown across them to the hallway by means of a motor driven fan.

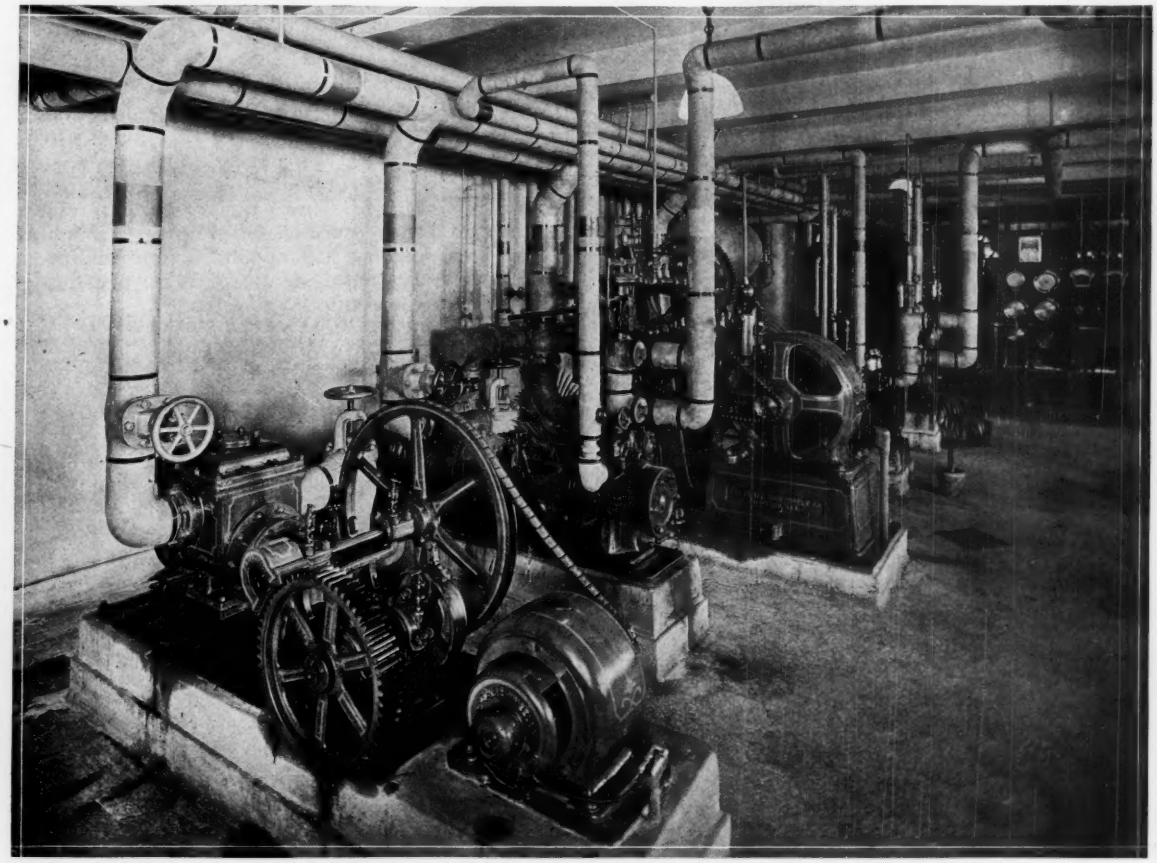


FIG. 7. PUMPS USED IN THE HEATING AND HOUSE WATER SYSTEMS

In connection with the heating system may be mentioned the house water heaters which supply the hot water for all lavatories of the building. They are heated by exhaust steam under the control of Foster thermo regulators which maintain the temperature of the water constant. Thermo traps drain the coils of the heater. These heaters also have live steam connections which can be used when the engines are not running.

House Water System

CITY water is used throughout the building, but the pressure at which it is furnished is not sufficient to carry it to the upper floors so the lower floors are supplied by direct city pressure while water used on

the upper floors is pumped to 2 tanks in the pent house, whence it flows by gravity as required. A Platt Iron Works Co. triplex pump driven by a 20-hp. motor and equipped with an Ashton relief valve is generally used for elevating the water from the city mains to the roof, while as a reserve, a Canton-Hughes duplex pump, 8 by 4½ by 10 in., equipped with a Fisher governor, has been provided.

By placing a check valve in the discharge pipe of the supply tank, and a Siamese connection at the street, water for fire protection can be taken from the service tanks in the pent house until the fire engine arrives, when the firemen can connect directly to the supply

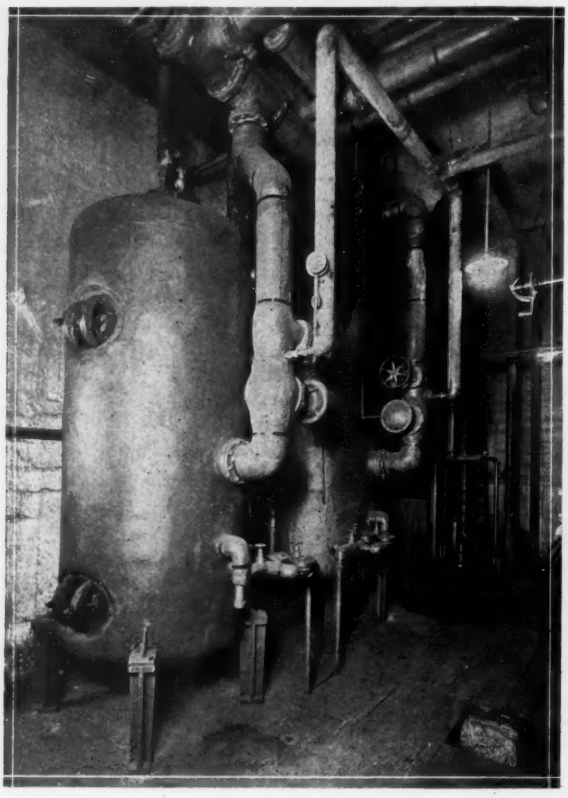


FIG. 8. HOUSE WATER HEATERS AND BILGE PUMPS AT THE REAR OF THE BOILERS

piping and submit it to any pressure which may be required without overflowing the supply tanks.

Storage Battery Equipment

WHERE a power plant of this size furnishes a large portion of its capacity for electric elevators, considerable advantage can be had by floating a storage battery on the line, thus maintaining a generator load that is without pronounced peaks and a remarkably steady voltage, a most desirable condition for lighting service. While the original intention in installing the battery was to use it for carrying the night load, the demands upon the plant of some tenants secured subsequently required that one of the generating units be kept in operation so the battery is floated upon the line supplying current to the elevators and the success of this arrangement has been remarkable.

Placed in a room by itself, the battery consists of 134 Gould's cells, 34 of which are end cells. These are connected on the 3-wire system for 110-220 volts. As ordinarily operated the battery is given an overcharge once a week. The distilled water used to replenish that evaporated from the cells is made in the plant and quite an item of expense is thus avoided.

The booster set located in the engine room and shown in Fig. 9, is the product of the Ridgway Dynamo & Engine Co., and consists of 1 25-hp. motor operating on 230 volts at 1500 r.p.m., 2 5-kw. generators supply current at 30 volts, 160 amp. and 2 1-kw. generators furnish current at 125 volts, 2 amp. These are all on 1 bed and direct connected to each other by couplings.

Switchboard

WERE you to make a casual observation of this plant, probably the most attractive equipment would be the switchboard. This is complete in every detail and is made up of 11 panels. Three of these are equipped for controlling the generators, each being supplied with 2 ammeters, 2 circuit breakers, 2 totalizing wattmeters, rheostat, voltmeter switch and knife switches. A gage panel has mounted upon it a recording pyrometer for flue gas temperature, a recording thermometer for feed-water temperature, both made by the Bristol Co., also a recording pressure gage for boiler pressure, a water gage for pressure on service pipes, an indicating steam pressure gage, a compound vacuum and pressure gage for the heating system, and an air pressure gage all made by the Ashton Valve Co.

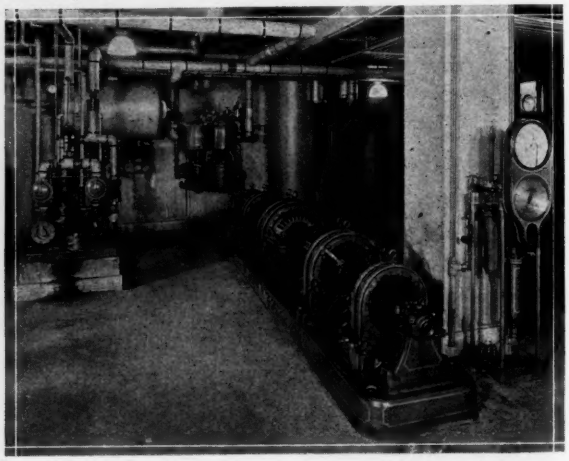


FIG. 9. AIR COMPRESSORS, BOOSTER SET AND VENTURI WATER METER

Aside from these panels are 2 for controlling the storage battery, 1 for the elevators and 3 service panels, while 2 voltmeters are hung on a bracket at the end of the switchboard. The board is the product of the Walker Electric Co.

Elevator Equipment

"AND Henry was shot up to the roof in the express elevator" or some similar expression is frequently read in stories but the author never stops to tell who did the shooting, but why should he, Henry was not hurt and probably the hero enjoyed the ride as did the writer when taken to the roof of the W. O. W. Building which has 6 elevators for passenger service, one being used also as required for handling freight. These are of the latest design Otis electric elevators, each being operated by a 30-hp. motor in the pent house where the controlling switchboards are located. The motors are rated for 220 volts, 130 amp. at 143

r.p.m. and are direct connected to the cable sheaves. Each elevator is a unit in itself being provided with a separate switchboard with circuit breakers, rheostats, safety devices, etc. An interconnected signal system has contacts operated by endless chain from each motor and a position indicator for the starter on the first floor is also operated by the motor.

To secure most efficient service from the operators, each car is equipped with a trip and travel recorder which gives the number of trips and the car miles and

FIG. 10. THE ELECTRIC STORAGE BATTERY

the record of each man is thus secured daily. The power required for each elevator is shown by a Sangamo integrating watt-meter. The readings are taken daily by the electrician and reported to the office on a blank, similar to that shown in Fig. 12.

As might be gathered from the foregoing description, throughout the entire plant there is a completeness of equipment which adds not only to the economy of operation but to the comfort of the employes. There is one room in which the tools are kept, the equipment

Date..... Remarks (.....)

Electrician's Daily Report

Woodmen of the World Building

Evevator A.....K. W. H.....Trips.....Miles

" B..... " ..... " ..... "

" C..... " ..... " ..... "

" D..... " ..... " ..... "

" E..... " ..... " ..... "

" F..... " ..... " ..... "

Signal Ap'tus.....

Repairs.....

Signed.....

Electrician.

FIG. 12. BLANK FOR ELECTRICIAN'S DAILY REPORT

consisting of wrenches, pipe wrenches, stocks, dies, taps, etc., of several sizes, a drill press, grindstone, work bench and other minor tools.

As a guide to the workman there is hung in this room a chart showing the color scheme for distinguishing piping, which is as follows: high-pressure steam, white; low-pressure steam, brown; sewer or soil pipe, black; gas, yellow; ammonia, red; water, green. All steam piping is covered with 85 per cent magnesia block covering which is wrapped with canvas and given a coat of paint, a band of the distinguishing color of paint is then put at frequent intervals.

Supplies are kept in another room suitably provided with shelves, racks and boxes. In this room also is a "light housekeeping" outfit with which the workmen can warm up their lunches or do a little cooking if desired.

In the employes' rest room are lavatories and a shower bath equipment greatly enjoyed during the hot days, each man also has a locker of ample size for his private use.

The design of the plant was worked out by the engineering department of Holabird & Roche, the

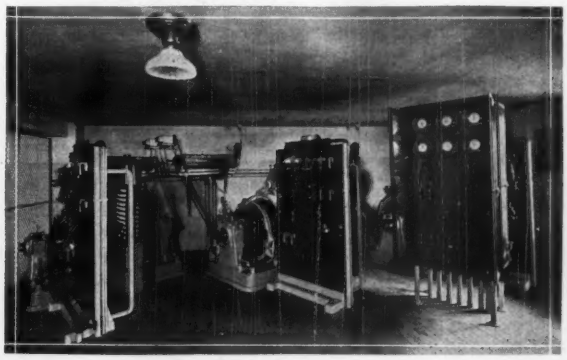


FIG. 11. ELEVATOR MOTORS AND SWITCHBOARDS

architects, and is now under the care of George W. Carr who sends a report to the office daily, that for March 14 being shown in Fig. 13. From these reports and the expense accounts kept in the office it has been

Date Mar. 14, 1913 Remarks (...)

Engineer's Daily Report

Woodmen of the World Building

Boiler X 2 3 ..... hrs. Coal 23000 lbs. Water Start 2706 cu. ft.

Unit No. 1 From 11 P.M. to 7 A.M. 8 hrs. ..... K W. Stop 750 K W.

Unit No. 2 From 7 A.M. to 11 P.M. 16 hrs. ..... K W. 5750 K W.

Unit No. 3 From ..... to ..... hrs. ..... K W. ..... K W.

House Pump 24 hrs. Water Meter ..... 45000 cu. ft.

Ice Mch. 16 hrs. 115 K W. Water 231 gal. 40 Deg.

Brine Pump 16 hrs. Average Thermometers Read 18 out 20 in. Deg.

Commercial Club Thermometers 40 Deg. ..... gal. Gas 100°

Cafeteria Thermometers 45 Deg. ..... gal. Water .....

Hot Water ..... 180 Deg. ..... Ashes .....

Air Pump ..... 1 ..... hrs. ..... K W. .....

Signed .....

Engineer.

FIG. 13. THE ENGINEER'S REPORT FOR MARCH 14

found that the power delivered to the switchboard costs on the average about 7/8 cent per kw.-hr., a remarkable showing for an isolated plant in an office building.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an examination for testing machine operator, for men only, on June 4, 1913, to secure eligibles to fill a vacancy in this position at $1800 a year, and vacancies in the position of assistant testing machine operator at salaries ranging from $1200 to $1600 a year, in the Bureau of Standards, Washington, D. C., and vacancies as they may occur in positions requiring similar qualifications.

Practical experience in the construction or operation of an emery testing machine is a prerequisite for consideration for these positions.

Age, 21 years or over on the date of the examination.

Persons who desire this examination should at once apply to the United States Civil Service Commission, Washington, D. C., or to the secretary of the board of examiners at any examination place for Form 1800. In applying for this examination the title Testing Machine Operator (Male), should be used.

ENGINEERS' CERTIFICATE IN NEW YORK CITY*

Chapter 733 and the Practical Application of the License Law

By Hubert E. Collins

AN act to provide for the licensing of firemen operating steam stationary boiler or boilers in the City of New York; accepted by the City; became a law May 13, 1901, with the approval of the Governor; passed, three-fifths being present.

The people of the State of New York, represented in Senate and Assembly, do enact as follows:

Section 1. It shall be unlawful for any fireman or firemen to operate steam stationary boilers in the City of New York, unless the fireman or firemen operating such boiler or boilers are duly licensed as hereinafter provided. Such fireman or firemen to be under the supervision and direction of a duly licensed engineer or engineers.

Section 2. Should any boiler or boilers be found at any time operated by any person who is not a duly licensed fireman or engineer as provided by this act, the owner or lessee thereof shall be notified, and if

No. 231 A.

City and County of New York, ss.

_____ *being duly sworn, deposes and says: I am an engineer holding a license as such and recorded on the books of the Steam Boiler Squad (Sanitary Company) of the Police Department of The City of New York; that I personally know* _____ *an applicant for a license as a Stationary Engineer in The City of New York, and that the contents of the letter signed by deponent certifying to the nature of employment and length of time of said service of said applicant* _____ *are true in all particulars.*

*Name*_____

*Residence*_____

Sworn to before me this _____ *day of* _____ *190*____

_____
Notary Public.

FIG. 5. BLANK FOR SIGNATURE OF SPONSOR

after one week from such notification the same boiler or boilers is again found to be operated by a person or persons not duly licensed under this act, it shall be deemed prima facie evidence of a violation of this act.

Section 3. Any person desiring to act as a fireman shall make application for a license to so act, to the steam boiler bureau of the police department as now exists for licensing engineers, who shall furnish to each applicant blank forms of application, which application when filled out shall be signed by a licensed engineer engaged in working as an engineer in the City of New York, who shall therein certify that the applicant is of good character, and has been employed as oiler, coal passer or general assistant under the instructions of a licensed engineer on a building or buildings in the City of New York, or on any steamboat, steamship or locomotive for a period of not less than two years. The applicant shall be given a practical examination by the board of examiners detailed as such by the police commission and if found competent as to his ability to operate a steam boiler or steam boilers as specified in Section 1 of this Act, shall receive within six days after such examination a license as provided by this Act. Such license may be revoked or suspended at any time by the police commissioner upon the proof of deficiency. Every license issued under this Act shall continue in force for one year from the date of issue unless sooner revoked as above provided. Every license issued under this Act unless revoked as herein provided, shall at the end of one year from date of issue thereof, be renewed by the board of examiners upon application and without further examination. Every application for renewal of license must be made within thirty days of the expiration of such license.

With every license granted under this Act there shall be issued to every person obtaining such license a certificate, certified by the officers in charge of the boiler inspection bureau. Such certificate shall be placed in the boiler room of the plant operated by the holder of such license, so as to be easily read.

Section 4. No person shall be eligible to procure a license under this Act unless the said person be a citizen of the United States.

Section 5. All persons operating boilers in use upon locomotives or in government buildings, and

POLICE DEPARTMENT

CITY OF NEW YORK

STEAM BOILER INSPECTION AND ENGINEERS' BUREAU

240 CENTRE STREET (Third Floor)

New York City, _____ **191**

To _____

_____

An examination for engineer _____ **class will be held Wednesday,** _____ **at 9 a. m. You are hereby notified to appear at that time and date. Bring pen and black ink.**

BRING THIS NOTICE WITH YOU _____ **Lieutenant Commanding**

FIG. 6. NOTIFICATION BLANK

those used for heating purposes carrying a pressure not exceeding ten pounds to the square inch, shall be exempt from the provisions of this Act. Such license will not permit any person, other than a duly licensed engineer to take charge of any boiler or boilers in the City of New York.

Section 6. This act shall take effect immediately.

The law as given does not give all details. For instance, after the applicant has successfully passed his examination and holds a third-class license, he is not eligible for promotion until after a stated period. An engineer in New York must hold a third-class license for 2 years before he is eligible to examination for a second-class license, and the holder of a second-class license is eligible to examination for a first-class license after holding a second-class license one year.

The applicant who comes to the city for the first time is eligible for examination for his license provided he carries a license from some duly authorized Board of Examiners in the United States or from any Marine Board. He is, however, entitled only to a third-class license on this first examination irrespective of the grade of license which he has held.

*Continued from page 458, May 1 issue.

Following Is a Copy of a Blank Certificate:

DATED March 20, 1913. Expires March 20 1914.

Engineer's Certificate issued by the Police Department of the City of New York, pursuant to Sections 342, 343, 344, and 345, Chapter VII, of Chapter 378 of the Laws of 1897 (Charter).

This is to certify that.....has been examined by practical engineers detailed as such by the Police Commissioner, as to his qualifications to take charge of and operate steam boilers and engines in the City of New York, and he was found competent and a certificate of the.....Class was granted to him and permission given to him to take charge of and operate the ..... steam boiler and.....situate at .....and registered on the books of the Steam Boiler Inspection and Engineers' Bureau as Boiler No. .....the steam pressure of which is limited by law to .....pounds.....

....

Examining Engineers. .....

Lieutenant Commanding Steam Boiler Inspection and Engineers' Bureau. Sanitary Company.

POLICE DEPARTMENT

CITY OF NEW YORK

NUMBER ON APPLICATION SHEET.....

DATE.....

CLASSIFICATION.....

.....

POLICE DEPARTMENT

CITY OF NEW YORK

DATE.....191....

CLASSIFICATION.....

A paper on which the name or number of the candidate appears will not be read

FIG. 7. EXAMINATION PAPER

This certificate authorizes the person named herein to take charge of and operate the steam boiler mentioned, but no other, and will be revoked on proof of negligence or insobriety.

Any person operating a steam boiler in the City of New York without a certificate from the Department of Police, and any person continuing to discharge the duties of an engineer after his certificate shall have expired, or been revoked, will be guilty of a misdemeanor. For .....

A reproduction of the engineer's certificate is also given, Fig. 1, page 456, May 1 issue. This is in blank form, and when issued to the successful candidate, is filled out with his name, the grade which is given him, and the specific plant which he is to operate under this license is designated on the certificate after which the 2 examining engineers and the lieutenant in charge affix their signatures. The grade given to the candidate is also stamped in large letters across the face of the certificate, being either first, second, or third-class.

Should the holder of this certificate change his position at any time, the certificate is transferred to cover the plant in which he takes a new position. In this event the holder of the certificate must secure a letter from his new employer stating that he wishes to employ him in his power plant. The examining engineers then issue a transfer such as is shown in Fig. 2, and this is pasted upon the face of the certificate until such time as the original certificate expires.

POLICE DEPARTMENT

CITY OF NEW YORK

STEAM BOILER INSPECTION AND ENGINEERS' BUREAU

MARKING SHEET

Classification..... Date of Examination..... 191

Candidate's Examination No.....

Question Number	Rating	Question Number	Rating	Question Number	Rating

Examiner

FIG. 8. EXAMINERS' MARKING SHEET

When the certificate expires, the engineer is to appear before the examining board. If they deem it necessary, he is re-examined as to his qualifications and a new certificate issued. In years past it has been the custom to notify an engineer when his certificate expires, but the examining engineer's department has been so greatly reduced that all unnecessary work must be dropped and at the present time an engineer is not notified when his certificate expires but is expected to note the time himself and appear promptly on the date marked on his certificate for the renewal of the certificate.

How to Proceed to Secure a License

THE candidate for examination must appear before the examining board in the Police Headquarters, New York City, and must fill out an application blank such as is shown in Fig. 3. The statement on this blank must be sworn to before a notary public. Figure 4 is the reverse side of the application blank. The upper half of this reverse side is reserved for the signature of at least 3 licensed engineers in the city who must sign in their own hand writing their names in full, and where they are employed. They must be men who have known the candidate for at least 5 yr., and who can swear as to the truth of the

POLICE DEPARTMENT
CITY OF NEW YORK
STEAM BOILER INSPECTION AND ENGINEERS' BUREAU
240 CENTRE STREET (Third Floor)

New York City,_____191

To_____

_____

At an examination held on_____you

passed satisfactorily with an average of_____% ~~Certificate enclosed.~~
Due for Certificate

_____
Lieutenant Commanding

POLICE DEPARTMENT
CITY OF NEW YORK
STEAM BOILER INSPECTION AND ENGINEERS' BUREAU
240 CENTRE STREET (Third Floor)

New York City,_____191

To_____

At an examination held on_____you

failed to qualify with an average of_____%.

Ninety days must elapse before you are again eligible to enter an examination.

_____
Lieutenant Commanding

FIG. 9. BLANKS USED FOR NOTIFYING ENGINEERS OF RESULT OF EXAMINATION

candidate's statement. These signatures of the sponsor of the candidate must be accompanied by a statement filled out on a blank as shown in Fig. 5, and must be sworn to before a notary public.

In the event of an applicant coming from some other city or locality holding a marine license or one from any authorized board of examiners in the United States or any other country, he must state in his application that he holds such a license and present it as proof together with his statement sworn to before a notary public that it is his own personal property.

In either case, the applicant must have a position in prospect before he is examined, and some responsible officer of the firm who wishes to employ him, must write a letter to the lieutenant in charge of the boiler squad testifying to that effect. This is done for the reason that the candidate may be specially examined for the identical plant in which he is going to take charge of the machinery.

In New York City a third class license entitles a man to take charge of any size plant as long as his employer wishes to engage his services.

Method of Examination

WHEN the department has on file in the neighborhood of about 30 or more applications, a date is set for the examination, and candidates receive a notice such as is shown in Fig. 6. The hour for examination is set at 9 a.m., and there are 2 sessions during the day. When all the candidates are assembled, they are asked to sign their names in a record book kept for that purpose, and after all of them have signed their names, the book is taken to the chief examiner who compares these signatures with those on the original applications. This prevents the appearance of a dummy at the examination.

The questions put to applicants are chosen in a novel way. In a card index in the office of the First Deputy, there are some 300 cards on each of which there is a question. These cards are brought to the examination room by MacKay and placed face down

No. 126 A.

TRANSFER OF STATIONARY FIREMAN'S CERTIFICATE.

Police Department of the City of New York,
300 MULBERRY STREET,

No._____ New York._____190__

This is to Certify that_____
has been examined as to his qualifications as a Stationary Fireman, and was found COMPETENT to operate Steam Boiler and Pumps situate at _____ under the direction of Licensed Engineer, and registered as Boiler No._____ Police Record, the steam pressure of which is limited by law to ____pounds, and he is hereby transferred to the said boiler, upon the application of the owner, as Stationary Fireman.

CERTIFICATE EXPIRES
_____ 190

_____
Sergeant Commanding Steam Boiler Inspection and Engineers' Bureau, Sanitary Company.

FIG. 10. FIREMAN'S CERTIFICATE

on a desk. He then calls one of the applicants to come forward and pick out a given number of these cards. The chosen cards are handed to a typewriter in the presence of every one to be mimeographed. A list of the questions are then given to each applicant who is started to work on the examination.

Candidates are given sheets of paper such as is shown in Fig. 7. At the top of the sheet is a detachable slip on which is written the date of the examination, the grade tried for, and the number which appears on the application blank. The chief examiner then writes a new number on this detachable sheet and the sheet which the candidate receives for answering his questions. The examiner detaches the top of the sheet, collects them together, and places them in a sealed envelope.

Candidates place the number of the question at the left-hand side of the paper, and write out their answers to that question on the sheet. They are allowed as much paper as they desire in order to complete answers.

The chief examiner holds the identifying slips in the sealed envelope so that no one knows to whom the papers belong until after the examination when the slips are taken out of the envelope and by means of the numbers thereon, which are the same as those on the original applicant blank filled out, can tell to whom the papers belong.

Before this is done, the examining engineers proceed with their work of marking the candidates' work. Two examiners each fill out a sheet similar to Fig. 8, and as they work independently, the chief examiner

takes the marked sheets and averages the rating given by the 2 assistants. This final average is the one which decides whether the applicant has succeeded or not.

The examination on boilers counts for 60 points, on engines, 30 points, and on pumps, 10 points. The candidate must secure a percentage of 70 per cent of the total 100 points in order to pass the examination.

After the examination, the department immediately rates the candidates and notifies them of their success or failure by means of one of the 2 blanks shown in Fig. 9.

Firemen's Certificates

APPLICANTS for firemen's certificates are treated in the same routine, and if successful they are given a certificate as shown in Fig. 10.

The Steam Boiler Inspection and Engineers' Bureau of New York City is at the present time in charge of Lieutenant W. H. Van Keuren, and the new system of examinations as herein described has been worked out by him in detail. A visit to the examining board will convince any one that they are very busy, and in fact they are over worked at times. But with Van Keuren's system, he has succeeded in eliminating favoritism and requires that candidates pass examinations on merit only. This is as it should be, and if the practice is continued the acquisition of an engineer's certificate in New York City will be an honor to any engineer.

At the present time there are about 25,000 engineers' certificates in force in New York City. 13,000 of these are active, or in other words, about 13,000 engineers appear annually to have their certificates renewed. A record of the last 8 months shows that an average of 90 applicants a month have applied for examination for their first certificates or to be raised to a higher grade.

Applicants should bear in mind that examiners are exceedingly busy, and—just the same as other examiners the world over—human. Almost without exception examiners throughout the world wish to be entirely fair with the applicants and are ready to listen to any just criticism of their examinations or methods, and the present examiners in New York City are no exception to this rule.

VERTICAL CURTIS TURBINES*

Precautions in Handling the Oiling System; Details of the Bearings

RETURN pipe or pipes to the filter must have sufficient fall, and be amply large, so that the oil may return freely and not overflow the lowest bearing.

High-pressure fittings must be strong enough to stand the working pressure and must be large enough not to give an excessive drop of pressure in the supply pipe line.

Owing to the viscosity of oil there is often considerable loss of pressure in pipes and elbows. Variation of temperature has a certain tendency to correct itself, since a less amount of lubricant will generally accomplish the same result when the lubricant is colder.

Oils

INASMUCH as the quality of oils on the market varies considerably, it is recommended that during the first period of service the action of the oil be observed with regard to the deposit of sediment and other foreign matter. If it is found that sediment is deposited, the brand of oil should be changed and its performance again noted, for if sediment is allowed to accumulate, it will prevent the free circulation of oil and result in damage to the bearings.

Oils to give satisfactory results should meet the following specifications:

Must be pure mineral, hydrocarbon oil free from tarry, slimy or saponifiable matters; acid, soaps or thickness; water, dirt, grit or other suspended matter. The specific gravity should be between 0.86 and 0.88 at 60 deg. F. The viscosity as determined by the Saybolt 104 deg. F. viscosimeter (Standard Oil Co.) should be not greater than 228 sec.

The cam shaft, bearing and rollers of the hydraulic gear are fitted with grease cups for lubrication. The gimbal bearing, the bearing supporting the emergency tripping device, the throttle valve and the various joints of the governor mechanism should be oiled occasionally from a hand oil can.

*Continued from page 408 April 15 issue.

Step Bearing

FEATURES essential to success in step bearings are that support of the lower block shall be rigid, that the surface bearing shall be at right angles to the shaft, that the lower end of shaft bears upon upper block in such a manner that there can be no working or springing of block, and that the clearance of guide bearings be such that alinement and position of shaft cannot vary appreciably.

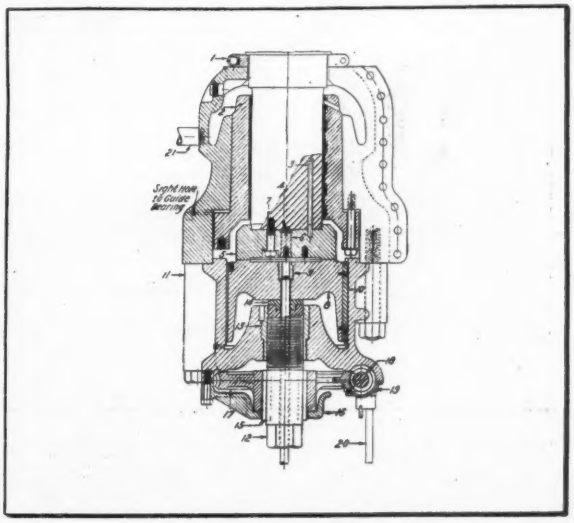


FIG. 17. SECTION OF STEP BEARING

1, Collar for supporting rotor when removing bearing; 2, Step guide bearing with holding bolts and keepers; 3, Guide pin; 4, Key for driving (5), with screws; 5, Revolving step plate; 6, Plug for (5); 7, Bolts and keepers for fastening (5) to shaft; 8, Stationary step plate; 9, Bushing and pin for (8); 10, Key for driving (8), with screws; 11, Step bearing head with bolts; 12, Adjusting screw; 13, Threaded bushing and pin for step bearing head; 14, Hardened steel cap for (12); 15, Key for driving (17) by (12); 16, Supporting bracket for (17), with bolts; 17, Worm wheel for adjusting device; 18, Worm and worm shaft for adjusting device; 19, Bearing cap for (18) and (11); 20, Ratchet handle for adjusting device; 21, Drain for step bearing.

Lower end of the shaft and the surface where it engages the upper step bearing plate should be carefully inspected. There should be no unevenness of surfaces. It is customary to recess the upper surface of the top block slightly, leaving an annular ring giving about ¾

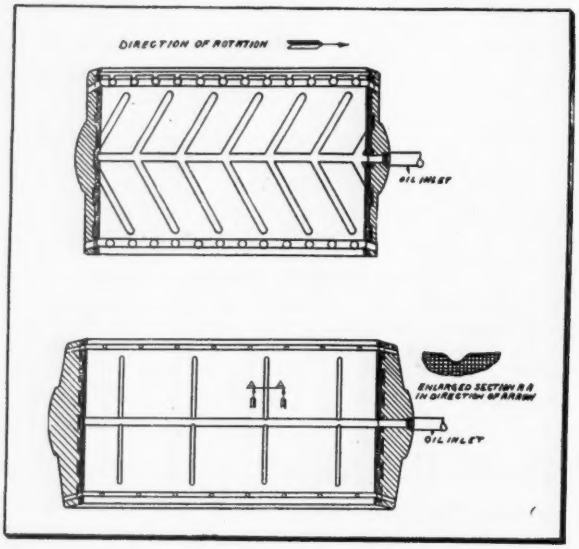


FIG. 18. SECTIONS OF UPPER BEARINGS

in. bearing for the shaft. It should also be noted whether the key in the upper plate properly fits into the recess in the shaft, also that the guiding pins provided in the upper block do not bind in any way.

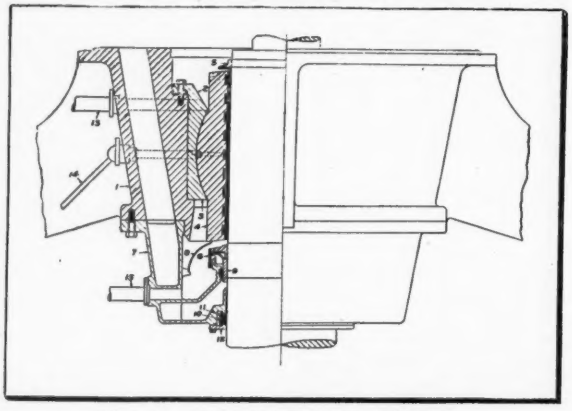


FIG. 19. TOP BEARING AND SUPPORT

1, Top bearing bracket; 2, Top bearing socket (upper) with bolts; 3, Top bearing socket (lower); 4, Spherical bearing; 5, Top bearing upper oil deflector; 6, Top bearing lower oil deflector; 7, Oil pan with bolts and keepers; 8, Oil guard—stationary; 9, Oil deflector fan; 10, Oil guard packing; 11, Oil guard packing spring; 12, Oil guard packing retaining ring with bolts and keepers; 13, Top bearing upper oil drain; 14, Top bearing oil feed; 15, Top bearing lower oil drain.

Lower block should be so held and supported that it cannot rock. A convex or defaced surface on the end of the adjusting screw will also cause trouble. The surface of the adjusting screw should be checked to see that it is at right angles with the axis; also it should be noted whether it turns true in threaded bushing.

Surfaces of the 2 blocks should be checked to see that they are all parallel. This includes the lower surface of the bottom block against which the screw bears.

Most step bearings are lubricated with oil at high pressure. In some cases where the water supply has been exceptionally free from impurities water has been used for step bearings, and in those cases the lower carbon packing has been omitted.

Upper Bearings

IT is absolutely essential in all bearings that a perfect oil film be maintained between the journal and bearing lining. In bearings on vertical shafts, if the clearance space is not kept filled with oil there is likely to be a rattling or chattering which will cause enlargement. It is desirable to supply the oil under sufficient pressure to maintain a perfect film at all times.

Where the oil supply is under pressure, it is only necessary to provide oil grooves of ample capacity to carry oil See Fig. 18. Where there is a low head on the oil supply, the grooves may be made to assist considerably in drawing a sufficient quantity of oil into the bearing, by placing them at an angle from the point of supply, in the direction in which the surface of the journal moves, with respect to the bearing. See Fig 18.

Oil grooves must have well-rounded corners on the trailing side as at A A, in Fig. 18. The bearing speed in some of the recent turbines is high and there will be a considerable production of heat even where there is no binding or heavy pressure. The temperature produced will be within the limits of good practice as the heat generated is carried away by radiation and by circulating oil.

Oil Throwing

WHILE oil throwing may be injurious to the generator windings, its most serious consequence is that it causes dust to stick in the generators which would otherwise blow through without impeding ventilation. A

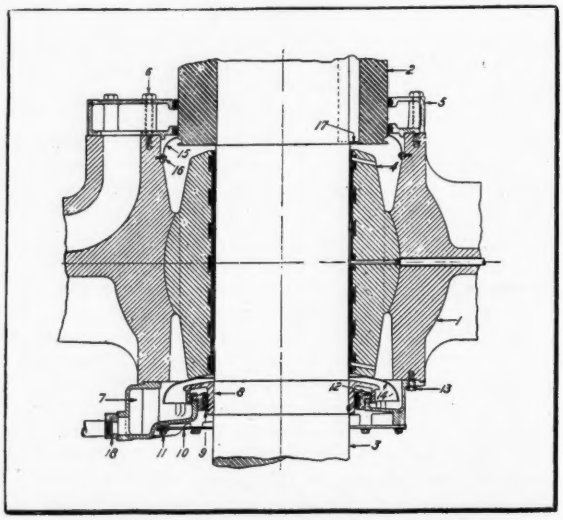


FIG. 20. SELF ALINING MIDDLE BEARING

1, Generator base and middle bearing bracket; 2, Coupling (turbine half); 3, Turbine shaft; 4, Middle bearing shell; 5, Oil guard (babbit packing) (top); 6, Bolts for (5); 7, Oil pan (bottom); 8, Oil deflector; 9, Babbit packing ring for (7); 10, Oil guard for (7); 11, Bolts and lock washer for (10) and (7); 12, Bolts and lock washer for (9) and (7); 13, Bolts for (7) and (1); 14, Oil guard inside of oil pan; 15, Oil guard for deflecting oil at top of bearing; 16, Screws for (15); 17, Steel ring to pack shaft and coupling at keyway; 18, Oil drain flange.

small quantity of oil escaping from bearings either in drops or in a vapor will cause this trouble in the same manner that the application of a small amount of petroleum to a road will prevent the dust from blowing off it.

In many cases oil throwing may be caused by some imperfect arrangements which allow the oil to drain directly out of the pans into the machine; but in most cases trouble from oil is caused by some tendency to

circulate air through the oil spaces. This air after passing through the oil pans is charged with a vapor, and when drawn into the machine does the damage. To prevent this it is necessary to equalize pressures and prevent such drafts or suction of air through the oil spaces.

Figure 19 shows the method of preventing air from being drawn through the oil pan under the top bearing into the generator, and Fig. 20 shows an application of the same idea to the top end of the middle bearing.

An air duct leads to the outside of the generator which tends to equalize the pressure in the babbit packed oil guards. Oil drain pipes run from both the top and the bottom of the top bearing, but only from the bottom of the middle bearing. Through the middle bearing there are vertical drains to take the oil from above to the drain pipe below.

In some cases the flow of oil or action of bearing may be interfered with by steam blowing against the bearing from packings. In such cases the leakage should be stopped or a ring should be put on the shaft between the bearing and the packing.

Care and Operation

BEFORE starting the turbine blow water out of the steam pipe by means of the drip placed outside of the throttle valve and also blow it out of the valve casing and adjust carbon packing drains; then open the throttle valve a small amount to permit steam to flow through the casing. Within a short time the turbine should be sufficiently warm. Observe the oil flow from the steady bearings at the drain manifold. The throttle valve should then be opened slowly until the turbine starts to turn. Bring the machine up to speed gradually and see that oil gages register properly; adjust the valves in steam supply to carbon packing, in order to avoid loss of vacuum, if the turbine is started condensing.

RECORD FORMS FOR ISOLATED PLANT

Economy of Operation is Checked by Use of 2 Records

By John Pierce

IF, in the call by Practical Engineer for "isolated" plant data, the word isolated means plants at the extreme end of nowhere, and miles from any machine shop, depending upon good luck, mostly, to keep running until extra parts can be sent out by express when anything goes to pieces, then I can hand in the following with the honest knowledge that I'm in charge of an "isolated" plant.

In this plant are found the several stages of engineering progress represented. We have one of the very first E. P. Allis engines, a 16 by 36-in. simple engine, which is either a right, or left, hander,—just as you choose to build your foundation; an old slide valve, which is retired; a Skinner high-speed automatic and now an American Diesel oil engine. We have 2 16-ft. by 60-in. boilers, equipped with the Higgins oil

HOUR	OIL READING	GAL. OIL USED	COST OF OIL	WATER READING	GAL. OF WATER	COST OF WATER	OIL AND WATER	KW. READING	KW.	GAL. OF WATER PER GAL. OF OIL	COST PER KW.
6:00 A.M.	85674			4400				1234			
6:30 A.M.	85945	271	5.42	4590	190	10	5 52	1334	100		
7:00 A.M.	86320	375	750	4700	110	.08	7 58	1444	100		

FIG. 1. FORM FOR RECORD OF AN OIL BURNING PLANT

HOUR	AMPERES PHASE 1	AMPERES PHASE 2	AMPERES PHASE 3	VOLTS #1	VOLTS #2	VOLTS PHASE 1	VOLTS PHASE 2	VOLTS PHASE 3	STEAM PRES.	TEMP. WATER	ATMOS. TEMP.	GAL. CRANK CASE OIL	GAL. CRANK CASE WATER	CYL. OIL GAL.	COMP. OIL GAL.	ENG. OIL GAL.	COST PER KW.-HR	REMARKS
6A.M.																		
7A.M.																		
8A.M.																		
9A.M.																		
10A.M.																		
11A.M.																		
12 M.																		
1P.M.																		
2P.M.																		
3P.M.																		
4P.M.																		
5P.M.																		
6P.M.																		

FIG. 2. FORM USED FOR RECORDING OPERATION OF OIL ENGINES

burner; one Westinghouse condenser, with its hot water, and air pump; one Marsh feed pump, one Knowles compound duplex pump for city pumping, and in passing, let me say that this old pump is a peach, as it is one of the first of the Knowles compounds. Also we have a Deane of Holyoke triplex power pump, for city pumping, one Goulds triplex power pump, and numerous motors, etc., also a complete board, though that has all sorts of arrangements of Noah's time on it, as well as some of the latest improvements.

We furnish all the power that is used in this little city, and have 8000 incandescents in service, and over 800 hp. of power load. Enough to swamp all our engines, were the entire load put on us at any one time. Yet we go by the theory that but few men think alike at the same time, and therefore all will not want their motors on at the same time. So far, it has worked out all right, and our peak is 200 kw., while our minimum is about 35 kw.

We have a "sliding" rate for both service and power.

The minimum rate is $1.00 a month, all metered, and the first 100 kw. power rate is 10 cents, from 100 to 200 is 9 cents, 200 to 300 is 8 cents, 300 to 400 is 7 cents and all over 400 is 5 cents per kw.-hr. For service we go down from 15 cents to 10 cents per kw. Coal formerly cost us $2.60 in the bin, and water 25 cents per 1000 gal. No records, more than the bills paid from headquarters, were kept while burning coal. When oil was put under the boiler, a record was kept, as shown.

We now have one somewhat similar, and which was made necessary on account of the addition of the oil engine unit. Our present record is as shown in Fig. 2, in addition to the power.

It may readily be seen that we aim to get a complete record of everything that takes place. We have oil meters, water meters, recording voltmeters, recording wattmeters, recording steam meters, recording thermometers for the cooling water of our oil engine, and in fact everything that might be of any advantage to us. Though we are miles from any machine shop, yet we have had the current on the lines continuously, with hardly a break and then never more than 20 min. each time, for over 5 yr. I venture to say that we do not exceed 5 hr. a year, that our lines are not loaded.

MISDIRECTED ENERGY

Getting a Reputation

By I. H. P.

THE night engineer, being a favorite with the high school boys, was pretty sure to have one or more of them drop in nearly every evening; he had established a sort of general mechanical and electrical information bureau, and many a knotty problem had been argued pro and con.

After a decision had been arrived at, the boys would present the problem, the following day, to their science teacher, who would handle the matter in professional style. Occasionally they asked him a facer, as in the case of the vacuum bottle, and by way of retort he sprung the "mysterious siphon," which went as follows: Imagine a siphon at sea level, one leg 50 ft. long, the other 1000 ft., both dipping in water. Fill the siphon and release both ends simultaneously. Problem: Will it siphon, and if so, why? If not, why not?

That evening, bright and early, saw 3 much fussed up students at the power house, patiently waiting till the engineer had his duties well in hand before getting his views on this question. He could plainly see out of the corner of his eye, that they were unusually worked up about something, but the spirit of mischief was strong in his make-up, and kept him fussing at any little task to keep him from his desk, around which expectantly waited his inquisitors. First off, one of the pilot lamps on No. 2 machine panel did not suit him, and he had to get a new one; then he sanded assiduously for 10 min. the 75-kw. commutator; then the sandpaper calling to mind emery-cloth, he hunted up a strip of the latter and striped the governor reach-rods of the new engine.

Next, he got something in his eye and had to spend several minutes trying to prop a 3-cornered mirror so he could get the light where he wanted it. After carefully removing the imaginary speck, he could plainly see that the arc on the west wall was undoubtedly good for 4 nights, at least, but nevertheless he shut it off, lowered it and proceeded to search earnestly for any hidden defect.

After relighting it, he brought forth his blue glasses and gazed thoughtfully at the flame from all angles. He next paid a visit to the furnace room, from which he returned soon with a white rag around a middle finger, and a piece of string in his mouth. Going up to the group he held his hand out and at once the boys were all solicitude, and 2 of them in their eagerness started to tie the finger at once. When the knot was ready to tie, the injured man turned quickly away, leaving his finger in the hands of the horrified boy, who, after his surprise had left him, unwrapped the cloth and found a 2 by 5/16 in. porcelain bushing. (This is a very amusing little trick when well performed, and is done by doubling the finger under, which is supposed to be hurt, and holding the tube with the other hand.)

This got them all to laughing, and they all said they knew he had been stalling along and that they were just getting ready to leave and not return. So the question was sprung and a rough sketch made to illustrate more fully, and the verdict awaited as the engineer leaned back in his chair and carefully went over the figures. With atmospheric pressure at 14.7, a column of water could be maintained 33.9 ft. high, or 0.434 lb. per foot in height. There certainly seemed no way to evade the issue, and turning to the group he said as much. Providing, of course, the pipe would not collapse or leak air. This, they declared, would not be allowed to happen in this particular case.

"Then it certainly looks to me like a 30-in. vacuum, if the pipe will stand it."

"It seems to me," said the first year man, "that if you once got her started running over the bend, the suction would do the rest and keep her going."

"Tut, tut; no such thing as suction," said the engineer, sententiously, still busy thinking. "I wonder at what temperature water boils in a vacuum," he said to himself.

Turning to his book, "Steam," and soon finding the place, he discovered that ebullition took place 58.8 deg. F. at 29½ in. mercury. Closing the book with a satisfied snap he relit his Pittsburgh stogie, tipped his chair back at a perilous angle, and smiled a patronizing smile. Then the oracle opened his mouth and spoke as follows:

"Starting with the fixed and fundamental principle which tells us that atmospheric pressure at sea level will force a column of water in a vacuum to a height of 34 ft.; we must regard this as immutable and consider the siphon with vacuum at the top and very little water having escaped. Now, experimental work has told us that water boils at a lower temperature than 212 deg. F. in a vacuum, tables fixing the boiling point as low as 58.8 deg. F. at 29.5 in. mercury.

"Now, armed with this information, we again regard the siphon; the water level of the long leg of which is slowly falling. Does this mean nothing to you? No? Then listen. The water boils, this fills with steam the space above the water, which dispels the vacuum, thereby dropping the water. And you can rest assured that this process will continue until such time as the water level in the 2 legs falls to that point which gives us something less than 29.9 in. mercury in the space above the water; or, in other words, when we have only some 30-odd ft. of water in each leg. Am I right? No? Well, think it over, and and the next time you come down bring something hard."

And thus it was that the night engineer got quite a little reputation among his small circle of acquaintances as being a hard man to sew up.

(To be Continued.)

FOREIGN DEVELOPMENT IN THE POWER PLANT FIELD

Large Hydro-Electric Plant; Electric Lamp Economy; Transmission Wire; Water Purification

By J. H. Blakey

THERE is now being constructed in Norway on the Nore River a hydro-electric plant which, when completed, will be the most powerful in Europe. It will utilize the Norefall, which the Norwegian government has bought for the purpose, and will supply electric energy for lighting and power to Christiania, the capital, and to the towns near by. The plant is situated at the foot of a mountain, upon which is the distribution basin. This basin will be fed by the waters of a reservoir at a distance of between 3 and 4 miles, which will be brought to it through tunnels. The height of the fall is about 1300 ft. According to the Technische Woche there will be 11 turbines of 20,000 hp. each, and 2 of 10,000 hp. The total disposable energy of the plant will be 216,000 hp.

Most Economical Working of Electric Lamps

IN L'Industrie Electric for October 25, M. Loppe analyzes a study of M. Block in the Electro. Zeits. for August 1, on the determination of the most economical conditions of the working of metallic filament lamps. With the lamps now on the market there may be advantage, according to their price and durability, and to the price of the electric current, in driving the lamps in such a way as to reduce the consumption per candle power at the expense of their duration, or to increase the consumption of current per candle power and to extend the duration of the lamp, fixing in advance a maximum reduction of the luminous intensity. The author shows how one can determine the consumption of the current and the duration of the lamp which are the most economical in each case, and gives examples of the application of formulas. He indicates also the rate of diminution admissible in practice of the luminous power of the lamp.

Galvanized Iron Electrical Transmission Wires

ESTABLISHMENT of a short electric line in the United States in which the transmission wires are of galvanized iron, has occasioned some remarks on this subject in the French journals. The matter has been thoroughly studied in France, and a number of small installations of this kind are now in operation in that country. The line in question serves a radius of 25 miles, and the current used is 3-phase, of 22,000 v. The conclusion arrived at is that for short lines galvanized iron wire is quite acceptable, notwithstanding its greater resistance, on account of its cheapness and its greater tensile strength, which allows the placing of the supporting posts further apart than with copper wire, and which also diminishes the liability to breakage by the accumulation of ice and snow on the wires.

Purification of Condensation Water by Electrolysis

IF a continuous current is caused to pass through water containing oil, the oil is separated (even if emulsified) and can be easily removed by passing through a filter. This property has been used in the Halror-Breda system. The warm condensation water is run into a wooden vat in which are placed the iron electrodes; in order to render it more conductive a little fresh water is added. According to the quantity of oil in the water the amount of energy required varies from 0.56 to 0.75 kw. per 1000 gal. to be treated. After some days the direction of the current is changed, and the oil rises to the surface as a foam which can be easily removed. This method of purification is in general use in England.

AIR LIFT EXPERIENCE

THE company with which the writer is connected has, during the past 7 or 8 yr., had in operation on the Pohle system 14 wells of an average depth of about 250 ft. These wells are in sand, interspersed with lenses of rather fine gravel. Some of the wells have 4, others 5, and others 6-in. discharge pipes, each having a 1¼-in. central air pipe. The water is found about 75 ft. from the surface, but, owing to the fine sand and gravel through which it must pass, there is considerable drop when the wells are pumping, the amount of drop depending upon the quantity of water pumped.

The lift at the different wells varies from 100 to 140 ft. Various submergences or heads have been tried from 60 to 35 or 40 per cent of the total head and lift. The wells being in almost constant use in connection with the works have made the conditions unfavorable for conducting a series of experiments or tests that would be of any particular value, but it is hoped that in the near future a favorable opportunity will offer.

As a means of obtaining a sufficient supply of water the wells have been a success, but from an economical standpoint per gallon of water pumped they have not been entirely satisfactory, and for this reason the writer some years ago undertook to work out theoretically the principles involved in the operation of the wells with the view of establishing the proper conditions for the most economical results. Formulas were deduced for determining the proper relation of head, lift, quantity and pressure of free air required, etc., with the expectation of confirming or disproving them by actual test, but so far, for reason stated above, without result.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

ALTERNATOR FREQUENCY

Effect of Leaving Some Poles Without Exciting Current

IN the March 15 issue, the question was asked by a correspondent, "What would be the effect on the frequency and the voltage of cutting out 2 field coils in an 8-pole alternator which ran at 900 r.p.m.?" The answer given to this question at the time was correct, but has been the cause of a good deal of correspondence recently, in which the difficulty has been as to just what the frequency of a machine is, and how it is determined, and it seems worth while to spend a little thought on the question.

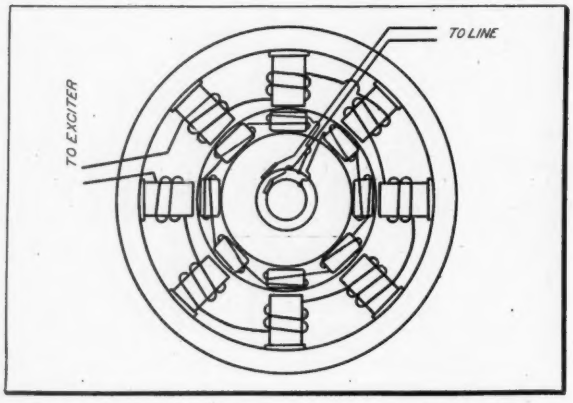


FIG. 1. SERIES CONNECTION OF FIELD AND ARMATURE

What is Frequency?

THE frequency of an alternating-current generator, is the number of cycles, or double reversals of current that occur in a second, and in most commercial machines today this is 60 cycles a second, or for some long distance transmissions, 25 cycles. A cycle is passed through by a coil in the generator armature, when it moves from in front of one north pole to in front of the next north pole, having meantime passed across a south pole. It is evident, therefore, that in going once around its path, or in making one revolution, a generator coil will go through as many cycles as there are pairs of poles; if this number of pairs of poles be multiplied by the revolutions per second, it will give, therefore, the frequency in cycles per second.

In the case of an 8-pole machine, we should have, therefore, 4 pairs of poles, and this times the revolutions per second, which for 900 r.p.m. would be 15, would give us 4 times 15, or 60 cycles a second as the frequency, which is correct for commercial practice. If, now, we change to a 6-pole machine, with the poles equally spaced around the armature, we shall have 3 pairs of poles, and if we ran the armature at the same speed as before, we would have 3 times 15, equals 45 cycles per second as the frequency. In the first case, one cycle is passed through in 1/60 of a second, and in the second case in 1/45 of a second.

If the 6-pole machine is to be used on a commercial circuit, it must run so as to give 60 cycles a second, and it would, therefore, have to be speeded up to 1200 r.p.m. In this case we should have 3 pairs of poles, and 20 revolutions a second, which would give us 3 times 20 or 60 as the frequency. In like manner for a 4-pole machine, the speed must be 1800 r.p.m. and for a 12-pole machine, 600 r.p.m., in order to give a frequency of 60 cycles a second for commercial work.

Connections of Generators

IN practically all alternating-current machines, connections are one of 2 kinds for both field and armature. Either all coils in each one are connected in series, or the coils are connected in 2 series, half of the coils being in each, and the 2 halves put in parallel. The first arrangement is indicated in Fig. 1, and the second arrangement in Fig. 2. As it is somewhat simpler to trace the course of events with the series arrangement, we shall use that in the rest of the discussion, but the principle would be the same in either case.

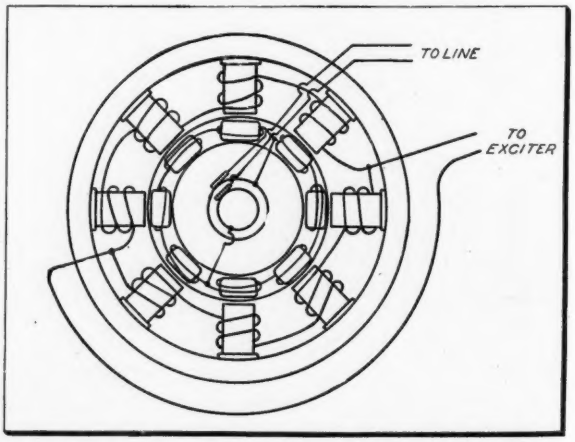


FIG. 2. PARALLEL CONNECTION OF FIELD AND ARMATURE

Cutting Out Poles

WITH the connections as in Fig. 1, suppose that 2 poles be cut out, that is, either the field windings removed or disconnected, and the field current sent past them, as shown in Fig. 3. The machine is to run at 900 r.p.m., as before, so that the time taken in passing from pole 1 to pole 3 is the same as if the coils on poles 1 and 2 were connected and active. Let us

follow the activity of coil A as it makes a complete revolution in the generator. Standing under pole 1, evidently it will cut no field excitation and therefore will be generating no voltage, and this will continue from the position opposite 1 until it gets over opposite field pole 2, because no lines of force are passing from pole 1 to pole 2. We would, therefore, have for our voltage curve a line along the axis as shown in Fig. 4. As coil A passes pole 2, it takes up some excitation because lines of magnetism from the excitation of pole 3 will be passing into pole 2. There is, however, only half the field strength that there would be if the coil on No. 2 was active, so that the voltage in passing from 2 and 3 will be only half the normal amount.

After passing pole 3, the coil A takes up its regular activity and from 3 around to 8 it is generating the full voltage for which the machine is designed. Between 8 and 1 there is excitation due to the coils on pole 8, but it is of only half the normal strength, so that the voltage generated will be only half its normal value, as shown on the curve of Fig. 4. The machine with 8 poles on the frame is still running at 900 r.p.m., and the time required for the coil A to pass from pole 3 to pole 5, for instance, is 1/60 of a second, the same as it would be if the coils on poles 1 and 2 were active. During 2 cycles and a half, the coil is generating full voltage, and during 2 other half cycles, it is generating half voltage, so that the voltage of the total circuit is ¾ what it would be if all poles were

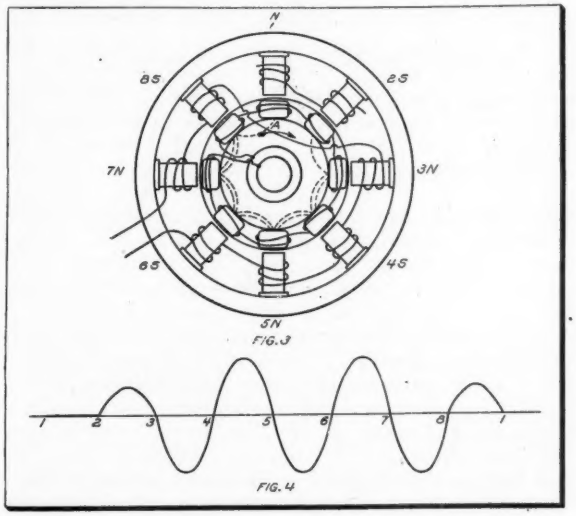


FIG. 3. CONNECTIONS OF 8-POLE GENERATOR WITH 2 ADJACENT POLES DEAD

FIG. 4. E. M. F. FROM 1 ARMATURE COIL WITH FIELD AS IN FIG. 3

active. The frequency, therefore, is unchanged, but the voltage is reduced ¼. Line voltage will not, however, vary as is shown in the curve of Fig. 4; for during the time that coil A is passing from pole 1 to pole 2, other coils which are in series with coil A are passing between other poles, and are thus generating voltage. The sum of these voltages is added together for the circuit voltage, which will be ¾ of that if all field coils were alive.

If instead of 2 adjacent poles, 2 opposite poles are put out of service, connections would be shown in Fig. 5, and the resultant generation of electromotive force by a single coil as shown in Fig. 6. Taking the coil A, while passing from 8 to 1, it is getting only half the excitation that it would if the winding on 1 were active, and the voltage will be half value; the same will be true in passing from 1 to 2; in passing from 2 to 3, and 3 to 4, it will get full voltage, while as coil on pole 5 is dead, it will get only half voltage in passing from 4 to 5 and 5 to 6. Then from 6 to 7 and 7 to 8 it will again get full voltage, completing the revolution. There will, therefore, be 2 full cycles giving full voltage, and 2 cycles giving half voltage, or, as before, we shall have the frequency unchanged, and the voltage decreased ¼ by cutting out the 2 poles.

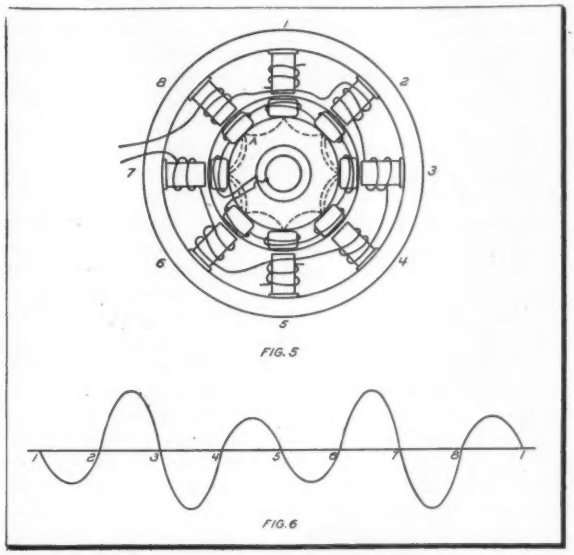


FIG. 5. 8-POLE GENERATOR CONNECTIONS WITH 2 OPPOSITE POLES DEAD

FIG. 6. E. M. F. OF 1 COIL FROM GENERATOR AS IN FIG. 5

In like manner, the result of cutting out any number of poles might be placed, but the general principle will always hold that the frequency will be unchanged so long as the total poles around the armature are unchanged, and the speed is constant, regardless of how many poles may be inactive.

The voltage will, however, be reduced in just the proportion that the number of pairs of poles cut out bears to the total poles on the machine.

HOW TO MAKE A RUBBER PATCH

THE Simplex Manual (a new edition of which is about to be published by the Simplex Wire & Cable Co., of Boston) gives the following directions for making a rubber patch:—

First of all scarf down the insulation on each side of the place to be patched, just as you would sharpen a pencil. Then scrape the insulation thoroughly clean some distance back from the scarf, taking pains to procure a smooth surface. Apply rubber cement and wait until it is almost dry. Then take patching rubber in the form of tape and, commencing on the scarf near its lower end, wind the tape spirally across the bare metal to the corresponding point on the other side, keeping it under all the tension it will stand. Keep winding back and forth rising higher and higher each time, until the tape is wound to a diameter slightly larger than the original insulation. Then vulcanize the patch or, if this is not done, cover the patch with ordinary friction tape, and paint with a good insulating compound.

INDUCTION MOTORS. PART III

Electrical Troubles

By JOHN A. RANDOLPH

IN the consideration of this feature of induction motor operation, we are led to a discussion of the faults which may at any time appear. The simple construction of the induction motor, especially those of the squirrel-cage type, renders it less likely to develop defects and to cause trouble than any other kind of motor. The conditions of load, however, are sometimes so strenuous that motors of the best design will give trouble unless they are carefully watched and the causes of impending breakdowns promptly removed. Moreover, surrounding conditions often have a tendency to injure the motor. These may consist of exposure to leaky pipes, dampness, extremes of temperature or dust.

The most serious troubles usually encountered consist of defects in the windings. They may be short-circuits or breaks in one or more phases. It may be said, in general, that the disorders which develop in the stator winding are practically the same as those which are encountered in stationary alternator armature windings with the exception that they are generally less serious in consequences because of the lower voltages usually employed on the motors.

One form of shortcircuit may take place in the copper of a coil. This results in making the coil inactive thus causing a corresponding reduction in the output of the motor and an overloading of the other coils of the phase affected. If easy of access, the fault may be often remedied without removing the coil, by the use of mica or other insulation.

A shortcircuit of another character may consist in the grounding of a phase on the frame of the machine in one or more places. If the grounding takes place in more than one place the effect is equivalent to a shortcircuit in the copper and its seriousness depends largely upon the amount of the winding thus bridged over or cut out of service. If this occurs in a single phase motor, it may result in a flow of current so heavy as to blow the fuses or open the circuit breaker or if not checked by these devices the heavy current may overheat the remainder of the winding resulting in a burnout if not detected in time.

Sometimes a shortcircuit, instead of being confined to a single phase, will occur between 2 phases if the motor is of the polyphase type. It may be caused by a grounding of the phases or through internal contacts between the copper. This will result in dangerous heating, an inequality of the respective voltages, and in a decrease of the output of the machine. The seriousness will depend upon the number of phases employed, the method of connection and the location of the fault.

In general, it may be said that shortcircuits may be detected by an unusual heating of the winding, an abnormal variation of voltages across the phases and a sluggishness in the operation of the motor.

Wrong Connections

IT may happen in making repairs or from other reasons that the connections of one or more coils are reversed. As a result the action of the affected coils will be opposed to that of the others, resulting in a lowering of the total voltage of the phase affected by twice the voltage of the affected coil and a corresponding decrease in the efficiency and output of the motor.

Another wrong connection may consist in the reversal of the connections of one of the phases. The result of this condition will depend largely upon the number of phases employed and their method of connection. If a 3-phase star-connected winding is used, the currents will be displaced by only 60 deg. instead of 120 deg. as they should be.

If the supply lines are wrongly connected to the motor terminals, a reversal of the direction of rotation will result.

Breaks

UNDER this heading may be classed the troubles which are due to breaks in the windings. If this happens in 1 phase of a 2-phase motor, rotation will continue, but only 1 phase will remain active. In a 3-phase machine, the result will depend upon the type of winding. If the delta connection is used, the motor will continue to run on the 2 remaining phases, but the latter will be overloaded. If, as is generally the case, the star connection is used, the motor will operate only on 1 phase. A 3-phase star-connected motor will start with a break in one phase, but with a break in 2 phases, it will be put out of service completely.

Disorders in Rotor Windings

IN the modern types of squirrel-cage rotors, trouble is not often encountered. In the earlier types, however, employing less stable connections, difficulty is sometimes experienced due to the melting of solder or loosening of joints. This results either in breaks or in the interposing of a high resistance in the path of the secondary current. When this occurs the rotor will either slow down or stop completely, its action depending upon the extent of the fault. The simple construction of this type of windings renders the location of these faults comparatively easy, hence they can be repaired without much difficulty. In squirrel-cage rotors of modern design the connections are made so secure as to render trouble from loosening or opening of joints exceedingly remote. The joints are often welded or are fastened with rivets, screws or bolts. Solder is also used, but the method of connection is such that there is little danger of melting.

Rotors of the wound type, however, are more liable to develop defects. There is always present the possibility of a break or of a shortcircuit. The winding used with rotors employing slip rings and external resistances is generally of the 3-phase star-connected type. A break in one of the phases will therefore cause the rotor to operate on only 1 phase. It will start but the remaining phase will be overloaded and the motor will operate at a reduced efficiency and output. A break in 2 phases, however, will put the motor out of commission completely, owing to the fact that no current can flow in the windings.

The faults which develop in wound rotor windings are very similar to those encountered in the stator windings. Their general result is to retard or stop the action of the rotor.

External Control of Apparatus

WITH motors employing external resistances, compensators and controllers, there is the added possibility of encountering trouble in the control apparatus. Breaks or grounds may occur in these accessories and

with the extra number of connections, the likelihood of loosened joints becomes more pronounced. Moreover, a finger of the controller may become bent, broken or loosened in such a manner that it does not properly perform its function. Again, one of the contact brushes on the rotor slip rings may become loosened or separated from the ring. These conditions may result only in an undue heating of the parts affected or they may be so located that, by the opening of circuits, they will cause the motor to refuse to start or to operate. Accumulations of dirt on brushes or contacts will also have a bad effect upon the efficiency of the apparatus.

Single-Phase Motors

A COMMON method of starting single-phase motors consists in phase-splitting by means of a choke coil or a condenser. One type of the latter is made by placing insulated iron plates in a solution of potash or soda. The effectiveness of such a condenser depends in large part upon the concentration and quantity of the solution. Under conditions of extreme heat there will be a tendency for the liquid to evaporate. If a very cold temperature prevails it may freeze. Evaporation or freezing of the liquid in the condenser will have a direct effect upon the starting of the motor and may be so serious as to cause it to fail to start at all.

ELECTRICAL CORRESPONDENCE

SOME TROUBLES OF AN OPERATOR

SOME years ago the writer was employed in a station where several 2300-v. single-phase lighting circuits were connected to a 3-phase busbar. Plug switches were used and the lines were protected by enclosed fuses. The sketch shows the arrangement.

By means of the copper strips shown, the load can be easily balanced. Each circuit has 3 plug switches but only 2 plugs are in at one time. The handle of one plug is red and is left in permanently when line is in use. For example take line 1 in sketch. Suppose red plug to be in on bar one and black plug to be in on bar 2. Suppose ammeter on bar 1 shows 75 amp., bar 2, 90 amp. bar 3, 60 amp. By moving black plug from bar 2 to bar 3, the meters would then read 75 amp. each, supposing that circuit to have 15 amp.

There are 2 panels of 4 circuits each, connected as shown in the sketch and by means just described, using a circuit having the required load, the load on the machine can be balanced to within 5 amp. or even better on a 400-kw. load which I think very good for a lighting load.

The only objection to this system is that an operator might get careless and put the plugs in a wrong place, causing a short on the machine, but so far as I know this has not happened yet and this system has been in 8 yr. or more.

When the switchboard was first installed, we had no means of telling when fuses were blown except by pulling them and testing with a magneto. In order to save time we were instructed, when notified of trouble, to pull the plug switch when a flash would give us an indication of whether the fuses were blown or not.

This method worked all right until our trouble man had hunted a couple of hours one night and found no trouble. He called me up and I pulled the fuses and tested them to find that one of them had blown. We afterwards learned that a ground through a pole lightning arrester caused the flash made by the switch, indicating apparently that the fuse was all right.

To prevent further trouble of that kind, a transformer was rigged up as shown by the sketch. By running the primary leads through insulated handles, we could connect the transformer to the terminals of the lightning arresters of the line being tested. The lamp would light if the fuses were good. Also, by grounding first one and then the other of the leads at C, we could get a fairly good indication of the amount of ground.

A year ago the writer had a narrow escape from burning out the step bearing on a vertical Curtis turbine. We had 2 boilers which were connected to a header, 2 valves being used on each boiler. When cutting in a boiler, the fireman would open one valve and when pressure was up, open the other.

One morning No. 1 boiler blew out a gasket and the fireman, being in a hurry, asked me to watch the gage on No. 2 and he would cut it in. I supposed he had one valve open as usual and when pressure was up told him to go ahead. He opened the valve on No. 2 and then closed the one on No. 1. When I went through the engine room door, I glanced at the gage board and there was but 80 lb. on the gage when we should have had 150.

It didn't take me more than 4 hr. to tell the fireman to open his other valve very slowly, trip the emergency throttle on the turbine, pull the switch

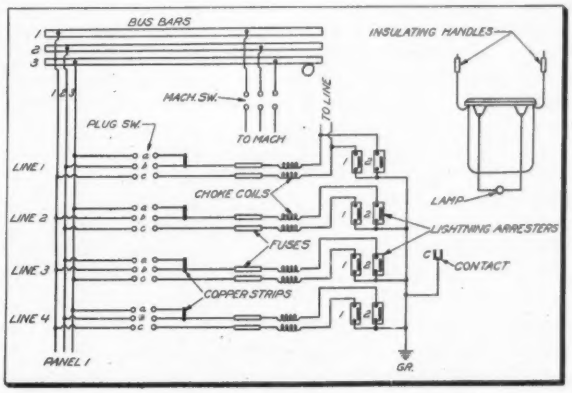


DIAGRAM OF ARRANGEMENT FOR DETECTING GROUNDS AND BLOWN FUSES

and open the throttles on the step pumps. The turbine slowed down pretty fast but it got enough oil to keep the step from burning. They say fortune favors the unwise; I am now pretty sure it does.

Since this happened, I have been sure to look at all valves before cutting in or out a boiler.

We have 2 plants here: No. 1 a steam and water plant, No. 2 a water-power plant alone. I am operator at No. 2.

Two years ago this winter I was sent to No. 1 plant to do some switchboard wiring, a spare operator being sent as my relief. That afternoon there was a short circuit on the line leading from No. 2. For some reason the relays did not trip the oil switch and the operator tripped it by hand. Thinking there might be some trouble in the switch itself, he took off the oil tank to find out. Not knowing what had been done, the operator at No. 1 told operator No. 2

to try the line again. He threw the switch in without putting the oil tank back on. The short circuit was still there and this time the relays worked. The readers can easily imagine what was done to the contacts of a 200-amp. switch with a voltage of 2300 and the relays set to trip at 250 amp.

When I got to the station and saw what had happened, I asked the operator why he did it. He replied he didn't think it would do any harm to put the switch in. I told him the harm was not in the putting in but in the coming out. After a few more remarks which further melted the switch contacts, I set about making repairs. W. H. Thompson.

SLOTTING COMMUTATORS

ONE of my men called my attention to several articles on slotting commutators, contributed by Mr. Pierce and Mr. Unsworth, in which they condemn the practice. If, after slotting their commutators, they continued to use hard abrasive brushes and commutator compounds, or if oil was allowed to reach the commutators in considerable quantities, I do not wonder at the fireworks that ensued. If, on the other hand, they kept the commutator free from oil and used tempered graphite brushes without lubrication, or if they used nonabrasive high grade carbon brushes with very little commutator compound, I believe that the results would have been highly satisfactory.

When I took charge of the electrical equipment of these mills 4 yr. ago, there were a number of motors that absolutely would not commutate. The commutators required frequent turning and matters went from bad to worse. I had seen very little slotting done at that time and was skeptical as to its merits, but I resolved to try it on the worst motor, as the trouble was evidently due to high mica.

The motor has now been in service night and day for 3 yr. with little sign of wear. The commutator is smooth and glossy. The result was so good that I slotted all the motors that sparked and the results were glossy commutators and sparkless commutation in all but 2 cases. One of these was a motor subject to excessive vibration caused by the gear drive. The other was caused by heavy momentary overloads; the slotting improved the commutation in both cases, but did not entirely eliminate sparking. I have never, in a single instance, had a punctured commutator after slotting although I have had a number of punctures on commutators not slotted.

There are motors and generators so liberal in rating and of such good design and construction that the commutation is inherently good. We have several of these and I haven't taken the trouble to slot them as it isn't necessary. I believe that a large percentage of commutator trouble is due to high mica and I firmly believe in slotting in all such cases.

The largest concern in this country manufacturing electrical machinery is now making a practice of furnishing its machines with slotted commutators and tempered graphite brushes. I have, within the past year, installed 2 of these machines, one a 225-hp. variable speed motor and the other a 200-kw. generator. Both machines carry heavy overloads with perfect commutation and glossy commutators.

Where commutation trouble is due to high mica I think that the commutators should be carefully turned and then slotted. Cut the slots not deeper than ⅛ in. and even less on small commutators. See that the depth is uniform and that the slots are clean cut. Remove all copper bridges from the bottom of the slot as well as all loose copper and mica. Scrape off the bars with a sharp scraper to remove burrs. Fit the commutator with a set of tempered graphite or nonabrasive carbon brushes and smooth the commutator with fine sandpaper. In case graphite brushes are used, keep all compounds, grease, etc., entirely away from your commutator. In the case of carbon brushes a small amount of good compound or vaseline may be used at times to stop any tendency to chatter but use as little as possible. Use only enough spring tension to insure good brush contact. I have found it advisable to give the brush considerable angle so that the rotation of the commutator acts against the spring. Where this is done no hard and fast rule with regard to the amount of angle can be laid down to apply in all cases, but from 45 to 55 deg. with the tangent of the commutator is usually about right.

Believing that this is a subject worthy of investigation, I would be pleased to hear from other readers of Practical Engineer. C. L. Hayward.

PIPES FOR CONDUITS

I WAS much interested in the article on Conduit Wiring in the March 1 issue of Practical Engineer.

There are one or two statements, however, that might, it seems to me, be misconstrued by parties not regularly engaged in electrical work—as, for example, mill foremen and janitors of large buildings, who are occasionally called upon to make repairs and extensions in their electrical plants.

It is a well-known fact that the use of ordinary pipe for conduit is liable to result disastrously.

Pipe as it comes from the mill has an interior surface which contains heavy scale which is as sharp as glass and liable to cut through the insulation on the wires. This is not the ordinary mill scale, but is the fluxing material used in welding the pipe.

Even though the particular pipe used, therefore, does not happen to contain burrs or fins, which are quite common, the roughness of the raceway due to the presence of this scale always presents an element of danger.

Except in short lengths it will be found almost impossible to fish wires through pipe of this character, as the rough interior surface prevents them from sliding freely. The wires will become jammed in the pipe and probably a block and tackle resorted to in an effort to dislodge them, with the result that the copper wire will stretch, reducing the cross-section to such an extent that the conductors instead of carrying easily the current which they were calculated to carry will offer so much resistance when the current is turned on that the pipe and surrounding material will be heated to the danger point.

The ordinary commercial galvanized iron pipe is even more undesirable for conduit than the plain pipe, as its interior surface contains, in addition to the scale and burrs above referred to, lumps of spelter which materially reduce the opening.

It seems to me that it might be a dangerous thing to point out to certain engineers or others that, for example, "more than a superficial inspection is required to distinguish the pipe so treated from conduit."

The only safe way of avoiding these difficulties is by using conduit which is manufactured specially for electrical purposes by a reputable manufacturer.

D. H. Murphy.

ESSENTIALS OF A STOKER

How These are Provided in the Murphy Automatic Smokeless Furnace

By J. R. Fortune*

IN the early days it was hard to persuade the average mechanical engineer that coal could be burned more economically and a greater capacity secured with a mechanical stoker than by hand firing, and Mr. Thomas Murphy, who began his work in 1878, had a hard up-hill fight convincing some of these skeptics that he was right. Even as late as 1890, the modified Dutch Oven of the Murphy furnace was often referred to as the Murphy dog house and eminent engineers frequently went on record as condemning all methods of mechanical stoking as less efficient than hand firing. Later, when coal handling machinery began to be used in connection with mechanical stokers, some of these parties modified their opinions and stated that mechanical stokers were not of any particular value except in plants large enough to use coal handling machinery, where the saving in the labor of handling the fuel would pay the interest on the investment.

Today, stokers are almost always considered when new boilers are installed and old settings are constantly being remodeled for stoker attachment. The mammoth power houses and large boilers of the present day would not be successful without the mechanical stoker, and the aggregate horsepower of mechanical stoked boilers runs into the millions.

For the Ideal Stoker

THE ideal mechanical stoker should have its coal hoppers so arranged as to be conveniently charged either from the chutes of the coal handling apparatus or by hand. These hoppers should be located in such a manner as to allow a full examination of the fire at all times. Murphy stoker hoppers are located in the sides of the furnace and are provided with openings in their tops, through which the coal can be admitted; also large doors are provided at their front end, by means of which the fireman can charge them when the plant is not equipped with coal handling machinery.

Being located at the sides of the furnace, an ample fire door can be placed in the front wall of the furnace through which every part of the fire can be observed. In many plants where the furnace is set out in front of the boiler, the coal is wheeled along an elevated platform and dumped on top of the furnace. Thus, the top of the structure forms an extension for the coal hoppers, and I have known of plants where a day's supply has been carried in this manner.

Uniform Feed

MECHANICAL stokers give higher results than hand fired furnaces because the coal is fed into the furnace slowly and uniformly over the grates. As they are usually provided with air feeding devices for furnishing air to the gaseous part of the fuel, analyses of the product of combustion indicate that their higher efficiency is produced by more thorough volatilization and combustion of that portion of the fuel than can be obtained with a hand fired furnace. Therefore, the perfect stoker should feed the coal into the furnace at the minimum speed. In our stoker the coal, being fed from both sides, travels slowly over the coking plate and is given ample time for the distillation of its gas as it cokes. The gas as it emerges from the surface of the fire is immediately met by currents of hot air discharged through the numerous ducts of the arch plates which are located right above the feed opening. The combustion of the gas then is promptly and economically effected.

After the coal emerges from the magazine, it should be transported over the grate surface at a speed proportionate to the rapidity of the combustion of the coke, or solid portion of the fuel, and should be kept constantly stirred if it is to burn quickly. If it is fed over the grates too fast, it will accumulate in the furnace and the fire will become too thick. If it is not fed fast enough, bare spots will form on the grates and the efficiency of the furnace will be reduced.

Refuse Disposal

WE also believe that a mechanical stoker is not complete until it is provided with automatic means for ridding itself of the ash and refuse which is produced by the combustion of the coal. The Murphy furnace has a practical clinker removing device, which is now arranged to operate automatically and which, when properly operated, will keep the grate surface clean at all times.

Furnaces of the side feed type burn more coal at the rear end than at the front, owing to the flame passing over the fuel and the tendency for a little more air to pass through the grates at the rear end of the grate surface. Our stoker is arranged to feed more coal at the rear of the grate than at the front and its clinker removing device is so designed as to enable it to discharge the additional amount of refuse which is produced by the additional coal burned at this point. It is necessary that the mechanism which operates the clinkering device of the stoker should be regulatable independently of the mechanism which feeds in the coal and that which operates the grates, as the percentage of ash varies with different coals.

Air Space

UNLESS ample air space through the grates and other air feeding devices of the furnace is provided, it is impossible to secure a proper capacity from the furnace. In our furnace the volatile portion of the fuel secures its air through a separate entrance from that through which the air is delivered to the grates, and this air, being drawn in above the fire brick arch, carries back into the furnace heat which would otherwise be wasted by radiation. The air, which is admitted to the ash pit, is not obstructed in its passage to the fire chamber, as the openings between the grates have an ample area.

This ample provision for admitting air to the fire chamber, permits of operating successfully and economically with the ordinary natural draft produced by the average boiler chimney, and the amount of grate, which is supplied for a given boiler with this draft, is sufficient to operate the boiler to 20 per cent of its rating; some plants are equipped also with forced draft, which is used when it is desired to operate the boilers beyond this point. For average work the stoker can be operated with high economy with natural draft and heavy overloads can be carried with forced draft. Due to the ample air spaces provided, we have found it possible to operate boilers to 300 per cent of their rating for 5 hr.

*Of Murphy Iron Works. Read before the Detroit Engineering Society.

at a time and this load was carried immediately at the end of a 12-hr. run during which the boiler was operated at 150 to 200 per cent of its rating.

In order that a mechanical stoker may be durable, it is essential that a considerable amount of cooling surface be provided for castings whose surfaces are exposed to the heat of the fire. All such castings as grate bars, the castings which carry the arches, and the coking plate are so designed as to expose an ample cooling surface to the air which is entering the furnace; for example, the grate bars have sometimes as many as 20 sq. in. of surface exposed to the cooling action of the air for each square inch exposed to the fire.

Emergencies

IN the event of any portion of the driving mechanism of the stoker breaking down, it should be possible to operate that stoker by hand until repairs are made, as frequently a boiler cannot be taken off the line and shut down. The coal can be fed in by hand, the grates shaken, and the clinker bar revolved.

The driving engine of a mechanical stoker must be substantially constructed and so designed as to require a minimum of attention, with the principal moving parts revolving in a bath of oil, speed instantly adjustable throughout a wide range and while the engine is in operation. The parts of this engine should be absolutely interchangeable.

A Hot Furnace

THE best authorities on the combustion of coal insist that a furnace should be entirely surrounded by incandescent surfaces if the coal is to be properly burned, and the cross section of the Murphy furnace shows that it conforms to this theory. Inclined fires on both sides of the furnace represent 2 of these surfaces, the arch another, the front wall of the furnace and the bridge wall of the boilers, others. We have always been strong advocates of the side-feed stoker; in other words, opposed firing. By this method of feeding coal into our furnace, the heat from the fire on the opposite side of the furnace and from the incandescent fire brick arch, causes the gas from the coal on the opposite side to distill rapidly,

Air, which is admitted to the furnace at the very point where the gas is discharged from the coal, mixes with it and the mingled gas and air pass downward over the surface of the fire toward the center of the furnace, and there meeting a similar current of air and gas from the opposite side of the fire, the combustion is thoroughly and speedily effected, the nature of the flame being similar to that which is produced by the acetylene gas burner with opposed delivery of gas.

The temperature of the fire which is produced in the Murphy furnace is determined by the United States Geological Survey at its fuel testing plant in Pittsburgh, is in the neighborhood of 3000 deg. F. The fire brick therefore, which is used in the furnace arch and the front wall, must be of the highest quality.

PRACTICAL MATHEMATICS

Duty of Pumping Station

DURING a 12-hr. duty trial of a double-acting pumping engine, the total number of heat units (B.t.u.'s) consumed by the engine was 188,765,300 and the pump made 64,800 strokes. The plunger was 26 in. in diameter, the plunger rod 4 in. in diameter and the stroke 44 in. The average pressure indicated by the gage on the discharge pipe was 160 lb., the average vacuum indicated by the gage on the suction pipe was 10 lb. and the distance between the centers of the 2 gages, 12 ft. What was the duty of the pump?

This problem can be solved by the following equation:

$$\text{Duty} = \frac{\text{Foot-pounds of work done}}{\text{Total number of heat units consumed}} \times 1{,}000{,}000$$

$$= \frac{A \times (P \pm p + s) \times L \times N}{H} \times 1{,}000{,}000$$

In which A = area, in square inches of pump plunger or piston, corrected for the area of the piston rod.

Area of plunger $= 3.1416 \times r^2 = 3.1416 \times 169 =$ 530 sq. in.

Area of plunger rod $= 3.1416 \times 2^2 = 3.1416 \times 4 =$ 12.6.

Net area of plunger $= 530 - 12.6 = 517.4$.

P = Pressure, in pounds per square inch, indicated by the gage on the discharge pipe = 160 lb.

P = Pressure per square inch, corresponding to indication of the vacuum-gage on the suction pipe = 10 lb.

s = Pressure, in pounds per square inch, corresponding to the distance between the centers of the 2 gages. Computation for this pressure is made by multiplying the distance, expressed in feet by the weight of one cubic foot of water at the temperature of the pump well and dividing the product by $144 = 12 \times 62.33$ (assumed) $\div 144 = 5.18$.

L = Average length of stroke of pump plunger in feet, 3.66 ft.

N = Total number of single strokes of pump plunger made during the trial = 64,800.

H = Total number of heat units consumed by the engine = 188,765,300.

Substituting figures for letters in the equation:

$$\text{Duty} = \frac{517.4 \times (160 + 10 + 5.18) \times 3.66 \times 64{,}800}{188{,}765{,}300} \times 1{,}000{,}000$$

$$= \frac{517.4 \times 175.18 \times 3.66 \times 64{,}800}{188{,}765{,}300} \times 1{,}000{,}000$$

As the water enters the cylinder by suction P ± p in the equation is P + p.

To solve this problem by logarithms, we first find the logarithms of the numbers in the dividend and as it is a continued product we add the logs to perform the multiplication operation.

We now find the log of the divisor and subtract it from the log of the dividend, to perform the operation of division. The last operation is adding the log of 1,000,000 to the remainder from the previous operation to find the log of the answer.

Log of	517.4	=	2.7138
" "	175.18	=	2.2432
" "	3.66	=	0.5635
" "	64,800	=	4.8116
			10.3321
" "	188,765,300	=	8.2758
			2.0563
" "	1,000,000	=	6.000
" "	Answer	=	8.0563

Answer = 113,900,000 ft. lb.

Condenser Surface

HOW many feet of condenser surface is required per engine horsepower?

Condenser surface is governed by the number of pounds of steam condensed in an hour, therefore the steam consumption of the engine governs the surface area per horsepower. Assume that we desire to figure the condenser surface required for a 1000-hp. cross-compound condensing engine which has a steam consumption of 15 lb. per horsepower hour, or a total steam consumption of 15,000 lb. per hour. The condenser surface is calculated by the formula:

$$S = \frac{W\,L}{c\,(T - t)}$$

S = Condenser surface in square feet.

W = Weight of steam condensed per hour = 15,000 lb.

T = Temperature in degrees F. of the steam at the pressure indicated by the vacuum gage which we will assume to be 135 deg.

t = Mean temperature of the circulating water or the arithmetical mean of the initial and final temperature which we will assume to be 75 deg. F.

L = Latent heat of the saturated steam which we will assume to be 1020 deg. F.

c = A constant found by experiment to be 180.

Substituting figures in the formula we have:

$$S = \frac{15{,}000 \times 1020}{180\,(135 - 75)} =$$

$$\frac{15{,}000 \times 1020}{180 \times 60}$$

Solving by logarithms:

Log of 15,000 = 4.1761
" " 1,020 = 3.0086

" " dividend = 7.1847

Log of 180 = 2.2553
" " 60 = 1.7782
" " divisor = 4.0335

We now subtract the log of the divisor from that of the dividend to secure the log of the total surface:

7.1847
4.0335

3.1512 = log of 1417

Then the condenser surface per horsepower will be 1417 ÷ 1000 = 1.417 sq. ft.

Safe Working Pressure of Copper Pipe

FIND the safe working pressure of copper pipe 6 in. in diameter and 0.175 in. thick.

Safe working pressure of a copper pipe is determined by the formula:

$$P = \frac{(T - 0.0625) \times 8000}{D}$$

In which P is the safe working pressure, T the thickness and D the diameter of the pipe in inches.

Substituting figures in the formula, we have:

$$P = \frac{(0.175 - 0.0625) \times 8000}{6} =$$

$$\frac{0.1125 \times 8000}{6}$$

Log of 0.1125 = 9.0511 — 10
Log of 8000 = 3.9031

12.9542
10

Log of dividend = 2.9542
Log of 6 = .7782

Log of quotient = 2.1760

Here, as in the previous problems, we have added the logs of the numbers composing the dividend and subtracted the log of the divisor from the sum to obtain the log of the answer. In column 9 on the line with 14 we find the mantissa 1732, which is the next smaller mantissa to 1760, so that the first 3 figures of the number corresponding to log 2.1760 are 149. The difference between the 2 mantissas is 28, we follow along the line to the supplementary table and find the difference, which is 27, and read 9 at the head of the column, which is the fourth figure of the number. As the characteristic is 2, the number of figures to the left of the decimal place is 3, therefore log 2.1760 = 149.9, the safe working pressure of the copper pipe in pounds per square inch.

The correct answer to the problem is 150, but in 4-place log tables there is a slight inaccuracy which acounts for the 0.1 difference between the arithmetical and logarithmic answers. The tables are, however, as accurate as the measurements involved in most problems and have a sufficient degree of accuracy for all practical problems.

INTERESTING HYDROELECTRIC DEVELOPMENT

THERE is being built at Beldens, Vt., for the Vermont Marble Co., of Proctor, a new power plant for furnishing electric power to the quarries in the neighborhood of Proctor, 40 miles away. There are to be 2 units of 1200 hp. each direct-connected to 800-kw. Westinghouse generators and running at 300 r.p.m. Each unit is a 1200-hp. double turbine manufactured by the S. Morgan Smith Co., York, Pa., the turbines having runners 33 in. in diameter, on a horizontal shaft, and the flow of water being controlled by the familiar wicket gate system. The discharge from the turbines runs through a draft tube 16 ft. in depth.

One of the interesting features of the new development is the fact that this plant is practically a duplicate of a similar plant built in 1910 at Huntingdon Falls, about 2 miles from Beldens. This previous development is operated also by S. Morgan Smith turbines, but the generators in this case are General Electric. Both plants will operate over the same set of transmission lines at high voltage, all of the power being used in the neighborhood of Proctor. One advantage of having the 2 plants so nearly alike is the fact that it is much easier to carry spare parts in sufficient quantity, resulting, of course, in better security against stoppage of operation.

MAGNALIUM is the name of a new metal now being tried out for pistons and connecting rods on automobile motors. Its specific gravity is 2.5 as against 2.56 for aluminum and 7.5 for cast iron, and its properties as a bearing metal are claimed to be better than babbit or phosphor bronze. The new metal is handled by G. A. Crayen & Co., of 81 New St., New York City.

HEATING A WHOLE TOWN

How This is Done from a Single Plant and the Construction Used to Get Transmission Economy

ONE of the largest operators in the bituminous field is the Berwind-White Coal Mining Co., and in many respects its most interesting operations are in and near Windber, Pa. This town which has a population of 12,000 and is situated high in the mountains not far from the city of Johnstown, is practically owned by the coal company and allied interests.

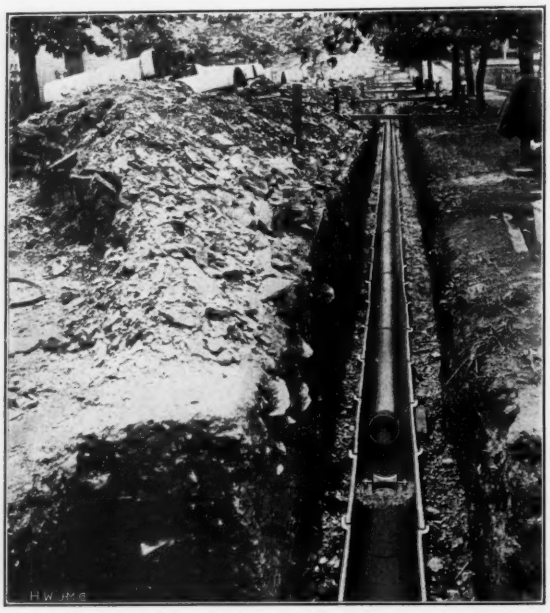


FIG. 1. LOWER HALF OF SECTIONAL CONDUIT, SHOWING PIPE AND ROLLER SUPPORT

Some years ago the Windber Heating Co. was formed and a large power house was built right at the entrance of the coal mine, to furnish power and light for the operation of the mine, also electric light, power and heat for a large portion of the town. At the present time this heating company is under contract to supply heat for 58,000 sq. ft. of radiation. In all the early installations the pipe was insulated but about a year ago one line was opened up and what was left of the covering was removed and J-M sectional conduit substituted. This proved so satisfactory that the company has recently opened up over 2000 ft. of steam line, taking it from the ditch and relaying it with the sectional conduit. Today it has in all a total of 3325 ft. of this system installed.

The recent installation of which some views are shown, is an 8-in. main line, running from the power house up a steep hill and down a stiff grade to the heart of the town where it connects with branch mains. There is no return line on this system, live steam being carried into each building at a low point, so that the return will flow back into a trap, from which it is allowed to go to waste.

Several difficult conditions had to be met, such as the line passing through coal veins and hard pan, through which surface water strong in sulphur percolated. Naturally this chemical-water rapidly ate the steel pipe away where it soaked through the old protection and it was necessary to remove a considerable quantity of pipe, although it had only been in 3 yr.

In laying this pipe line it was originally found necessary to cross under the gutter of a roadway which carried mine water strongly charged with sulphur. In laying the new conduit and pipe at this point, the course of the steam was temporarily diverted while the conduit was laid across its path. A concrete dam was constructed in the gutter with the conduit imbedded in it, this preventing the backfilling from washing away, securely holding the conduit in line and keeping it free of danger from sulphur water.

As originally laid, the pipe was allowed to take the curvature of the ditch, with unnecessary strains placed on joints, resulting in their leaking. In laying the J-M conduit care was taken to secure the correct grade. The ditch was dug 3 ft. wide and to the necessary depth. In the bottom of this ditch another ditch 9 in. deep and 12 in. wide was made, and in this was laid a 6-in. drain, the bottom of which was covered with 6 in. of crushed stone of rather coarse grade. Upon this was laid a layer of fine chip stone, to form a fairly even bed for the bottom half of the tile conduit.

At every fifth section of tile was a supporting tee, with the bell of the branch down, and the base filled to the flow line of the conduit with rich concrete, as will

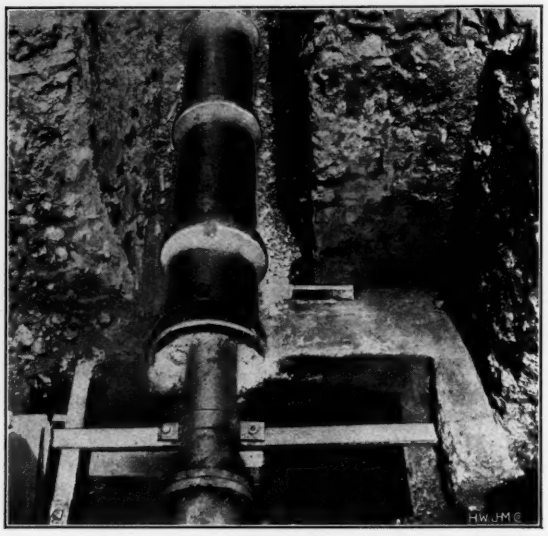


FIG. 2. INSTALLATION AT MANHOLE, SHOWING USE OF FILLING

be noted in Fig. 1. In this concrete were set frames with exactness as to height, designed to carry the entire weight of the pipe and permit it to move under expansion and contraction without placing strain on the tile conduit.

The steam pipe was then laid and the expansion joints were placed in the line at proper intervals, to take care of the expansion and contraction of the pipe. All expansion joints were placed in manholes. Then the pipe was subjected to a hydraulic water test of 20 to 60 lb. according to the steam pressure to be carried in the line where the test was made.

The top halves of the conduit were then placed in position, the longitudinal joints being well washed with neat cement mortar and the bell joints cemented to insure their being water-tight.

After each top section had been secured in place Asbesto-Sponge filling was packed in the conduit around the steam pipe, as shown in Fig. 2. Crushed stone of medium size was then filled in until the bells of the second half were covered with 3 in. of stone; then the ditch was filled up and tamped.

The manholes were made with 13-in. concrete foundation walls to a height even with the top of the lower half of conduit. The conduit was brought through the manhole walls, so that the edges of the tile were flush with the inside of the walls. In order that the tile should have all bell ends in the manholes, unions were used in laying the first sections on the down grade side of all manholes. Over these concrete foundation walls, brick walls were built and brought in at the top to the proper size to receive the manhole plates. Wherever the tile entered the manholes the pipes were covered with sleeves of J-M Sectional Asbesto-Sponge felted pipe covering and the openings around these closed with a shutter.

Aside from its simplicity and facility afforded for its rapid installation, the conduit is impervious to water and acids, and by the nature of its construction, the weight or movement of pipes cannot injure the conduit. It can be opened up for inspection or removed and relaid without damage to the conduit.

POWER PLANT CHEMISTRY

Determining Heating Value of Coal from Proximate Analysis

CERTAIN chemical changes take place with the liberation of heat, among these is the uniting of oxygen with other elements or compounds. The amount of heat which is given off depends upon the elements uniting and, of course, the quantity. For example, if we burn hydrogen in oxygen forming water in gas form, or steam at 212 deg. F., there would be 51,700 heat units liberated for each pound of hydrogen burned. Likewise burning carbon to carbon dioxide (CO_2) at ordinary temperatures about 15,500 heat units would be liberated per pound of carbon; carbon to carbon monoxide (CO) gives 4451 heat units; marsh gas (CH_4) to water and CO_2 gives 23,594 heat units, etc.

PROPERTIES OF COMBUSTIBLE SUBSTANCES*

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Name of Substance	Physical State	Chemical Symbol	At. Wt.	Mol. Wt.	Products of Combustion	Weight per Pound of Substance	Heat of Combustion	Latent Heat of Steam Formed	Pounds Ox. per Pound of Substance	Pounds Air per Pound of Substance	Nitrogen per Pound of Substance	Water Equiv. of Products of Combustion in Ox.	Water Equiv. of Products of Combustion in Air.
Carbon	Solid	C	12	...	CO_2	3.67	14,500	.....	2.67	11.50	8.83	0.693	2.848
					CO	2.33	4,300		1.33	5.76	4.45	0.366	1.631
Hydrogen	Gas	H_2	1	2	H_2O	9.00	62,032	9471	8.00	34.80	26.80	4.15	10.69
Phosphorus	Solid	P	31	...	P_2O_5	2.29	10,350	.....	1.29	5.60	4.31		
Sulphur	Solid	S	32.1	...	SO_2	2.00	4,030	.....	1.00	4.35	3.35	0.308	1.125
Carbon monoxide	Gas	CO	...	28	CO_2	1.57	4,380	.....	0.57	2.48	1.91	0.297	0.763
Marsh gas	Gas	CH_4	...	16	CO_2	2.75	23,600	2370	4.00	17.40	13.40	1.336	1.883
					H_2O	2.25							
Acetylene	Gas	C_2H_2	...	26	CO_2	3.39	21,430	727	3.08	13.40	10.32	0.960	1.212
					H_2O	0.69							
Benzol	Vapor	C_6H_6	...	78	CO_2	2.39	18,200	727	3.08	13.40	10.32	0.960	3.48
					H_2O	0.69							
Ethylene	Gas	C_2H_4	...	28	CO_2	3.14	21,330	1360	3.43	14.90	11.47	1.189	3.99
					H_2O	1.29							
Alcohol	Liquid	C_2H_5OH	...	46	CO_2	1.92	12,930	1233	2.09	9.10	7.01	0.903	2.61
					H_2O	1.17							
Gasoline	Liquid	.....	...	...	CO_2	3.11	20,700	1490	3.43	15.10	11.66	1.221	4.062
					H_2O	1.37							
Fuel oil	Liquid	.....	...	...	CO_2	3.06	20,000	1390	3.41	14.80	11.42	1.187	3.972
					H_2O	1.32							
Sugar	Solid	$C_{12}H_{22}O_{11}$	...	342	CO_2	1.53	7123.6	608.4	1.12	4.92	3.78	0.559	1.490
					H_2O	0.578							
Cellulose*	Solid	$C_6H_{10}O_5$	...	162	CO_2	1.63	7,570	585	1.185	5.16	3.97	0.564	1.533
					H_2O	0.556							
Pennsylvania anthracite†		9.2% ash			CO_2	.....	12,900						
Pennsyl. bituminous coal†		7.9% ash			CO_2 & H_2O	.....	13,940		per lb. of dry coal				
Colorado lignite†		13.1% ash			CO_2 & H_2O	.....	10,700						

*The combustible matter of wood consists of cellulose and turpentine. The heating value of air-dried wood varies from 6800 to 8000 B.T.U. per pound.
†The results given are the average for the region.

It becomes, then, a simple matter of arithmetic to calculate the amount of heat a fuel will liberate, if the ultimate analysis of the fuel is to be had. The ultimate analysis of coal is, however, too complicated a process for the power plant, so we must confine ourselves to what we can learn from the proximate analysis.

Before taking up a discussion of the various formulas which have been worked out by different authorities, a little explanation of what is meant by heat units and the conversion from one system to another will be of value.

Heat is measured by determining its effect upon the temperature of some chosen substance. For example, we may say that a certain grade of coal contains 12,000 B.t.u. of heat, but what is really meant is that when 1 lb. of that coal is burned to carbon dioxide, it will raise the temperature of 12,000 lb. of water from 39 to 40 deg. F. By this means, then, we are able to compare the heating values of various fuels.

There are 2 units of heat now in common use, known as the British thermal unit (B.t.u.) and the calorie or French unit. The British thermal unit is the amount of heat necessary to raise the temperature of 1 lb. of water 1 deg. Fahrenheit at or near 39.1 deg. The calorie is the amount of heat necessary to raise the temperature of 1 kilogram of water 1 deg. Centigrade at or near 4 deg. C. One calorie = 3.968 B.t.u. or 1 B.t..u = 0.252 calorie. If the heating value of a fuel is given in calories per kilogram, multiply this value by 1.799 and the result will be the B.t.u. per pound, or multiply the B.t.u. per pound by 0.5559 and the result will be calories per kilogram.

The method of determining the heat liberated by a chemical change is usually by means of a calorimeter, an apparatus so constructed that all the heat liberated during combustion is absorbed by water, the temperature of which can be determined at short intervals before and after combustion.

In the accompanying table are given the properties of combustible substances which have been found by the best authorities and published by F. E. Cardullo.

As was previously stated, with an ultimate analysis of the coal we could, by using the above table, determine quite accurately what heat would be liberated by burning it; but the following formulas are of value in estimating the heat value from the proximate analysis.

For West Virginia coals, F. Haas has found this formula to give a close approximation:

B.t.u. per pound = 156.75 (100 — % ash — % sulphur — % moisture) + (40.50 × % sulphur).

In the French system this may be represented by:

Calories per kilogram = 87.1 (100 — % ash — % sulphur — % moisture) + (25.50 × % sulphur).

Goutal's formula has been found to give quite accurate results with German coals but is rather complicated to use. It is as follows:

82 C + aV = calories per kilogram, where C = per cent of fixed carbon, V = volatile constituents, "a" is a variable factor depending upon the volatile constituents, V_1, of the pure coal, free of water and ash.

$$V_1 = \frac{V \times 100}{C + V}$$

The following table gives the values of "a" corresponding to values of V_1 from 1 to 40.

*From 'Practical Thermodynamics,' by Forrest E. Cardullo, copyrighted 1911 by the McGraw-Hill Book Co.

V_1	a	V_1	a	V_1	a	V_1	a	V_1	a	V_1	a	V_1	a
1-5	150	10	130	16	115	21	108	26	102	31	97	36	91
5	145	11	127	17	113	22	107	27	101	32	97	37	88
6	142	12	124	18	112	23	105	28	100	33	96	38	85
7	139	13	122	19	110	24	104	29	99	34	95	39	82
8	136	14	120	20	109	25	103	30	98	35	94	40	80
9	133	15	117										

Hunt's formula gives another method of approximating the heat available and is:

B.t.u. per pound = (146. × % fixed carbon) + (165.50 × % volatile combustible matter), or using the French system, calories per kilogram = (81.1176 × % fixed carbon) + (91.9518 × % volatile combustible matter).

To show how closely the results from these formulas come to the heat value as determined by a calorimeter, a test was made of coal whose proximate analysis was as follows:

Moisture	1.460	per cent
Volatile	10.880	" "
Fixed Carbon	81.535	" "
Ash	6.125	" "
	100.000	" "
Sulphur	.807	

Calories per kilogram determined by calorimeter 7778, or 13,992 B.t.u. per pound.

By Haas' formula:

$87.1\ (100 - 6.125 - 0.807 - 1.460) + (40.50 \times 0.807) = 7999$ calories per kilogram.

By Goutal's formula:

$$V_1 = \frac{10.88 \times 100}{81.535 + 10.88} = 11.78$$

From the table we find that with V_1 equal to 11.78, $a = 124.7$:

Then

$82 \times 81.535 + 124.7 \times 10.88 = 8068$ calories per kilogram.

By Hunt's formula:

$81.1176 \times 81.535 + 91.9518 \times 10.88 = 7614$ calories per kilogram.

It will be noted that these formulas are only approximately correct for the coal tested but will give a fair idea of the heating value, for with Hunt's formula the percentage of error compared with the calorimeter test is a trifle over one per cent; with Haas' formula, less than 3 per cent and with Goutal's formula, less than 4 per cent.

If more accurate results are desired, a calorimeter test should be made, directions for which will be given in the next article of this series.

CORRESPONDENCE OF AN OLD ENGINEER AND HIS SON

The Oiling System Pleases Sandy and He Recalls Old Times

MY dear son Donald:—

Although I am not feeling very well tonight, yet I will try to answer your letter of a few weeks ago, for I should have written sooner. But my old friend, the rheumatiz, sort of threw the belt off for a few days and there was nothing that I could do but help mother keep house and do nothing. Oh, I went down to the store and talked politics a little, once in a while, but as every man there wanted to reform the country in a different way, I didn't say much, but listened to the others spout.

Well, Donny boy, I was very much interested in your oiling system, as you call it, although such things were unknown till long after I left the game. In my days before the war (I mean the Civil War, a real war, not this comic opera affair we had with Spain), such a thing as an oil cup, especially a glass one was almost unknown.

If there was a cup at all, it was of the crudest kind, which was filled with waste or lint, and filled with whale oil which was allowed to get in its work, whether the machine was running or not. I recall one engine I ran in a rolling mill back in Philadelphia, quite a large one for those days, didn't have a single oil cup on it, not even on the crank pin.

There were ordinary oil holes on everything, and it was a case of holding onto the railing with one hand and with the other guide the snout of an oil can (usually a home-made affair) into a small hole on the top of the rod as it swung around on its 7-ft. stroke.

Those were hard days, and maybe some day when I feel just right, I will write you a long letter and tell you about some of those early trials that we had. Why, right here in this little village, the fireman over to the Fillman & Kissenhoefer Co., thought that it was too much to ask him to blow the flues with some new kind of a steam cleaning apparatus. Why, what would he have done had he been in some of the places from 1850 to '60, or along there?

I have seen many a boiler that had never a sign of a tube at all and lots of them with 6-in. riveted flues, sometimes as much as 30 ft. long. Flue scrapers were not bought then; they were made. And it isn't the snap it looks to be to clean a riveted flue 6 in. in diameter, and anywhere from 24 to 30 ft. long.

Yet here are some of these present day engineers and firemen who are always grumbling because they have too much to do (?). Some of these fellows forget that you never have the chance to get more than you earn till you earn more than you get.

But to go back to the oiling system, as you call it, for I didn't intend to stray away from the subject like this. I am glad to see that you are looking out for the interests of your employer in the matter of saving oil. Of course, it saves you some steps and work also, but employers, as a general thing, do not install appliances for the sole purpose of saving steps or saving work on the part of the power-house employes, for some of them do mortally hate to see an engineer or fireman sit down between spells. I knew a place once where the boss brought in the material and had the fireman nail up boxes between fires.

While I do not know much about the oiling system that you built, only in a general way, yet I have not forgotten so much but that I can appreciate what a job it was to do all the work, plan it all, and lay it all out, even if Wilson (as you call him) did do most all of the actual muscular work.

It shows me, Donny boy, that you are beginning to get into the harness in reality, to go about a proposition just as you find it and get away with it. Why, I know lots of fellows who would put such a job down as an impossibility, while all it needed was a little intelligent thought.

There are any number of little things just like the oiling system about almost every power plant that can be improved and money saved by going at it in the right way. All it needs is brains well mixed with elbow grease. But a home-made chair tipped up against the wall with your feet crossed on top of the waste can will spoil the recipe every time.

One day, oh, a number of years ago, I remember strolling into a little engine room just to get a good smell of hot cylinder oil once more, and found the combination man sitting on a nail keg in the door back of the boiler, with his back against one jamb, and his feet against the other which brought his knees up pretty close to his chin. He looked to be about as comfortable as if sleeping in a wheelbarrow.

He was part Yankee, and part common laziness. He was whittling as many lazy men do. The boiler feed was a crude affair driven from a belt driven "head" bolted to the ceiling. As the single acting plunger came down, the water squirted up to the ceiling and onto another belt.

While I make it an ironclad rule never to criticise a man's engine room (no matter how much it needs it), yet on this occasion it seemed to be the proper thing to do, so I said:

"Why don't you fix that boiler feed pump?" "Why?" he replied, straining himself sideways to get a glimpse of me. "Well, I hain't got time,—now,—and besides she's a-runnin'."

That's like old Sam Bickels who used to fire at a little plant back in the days when you were a boy. Sam didn't have either the ability or else the inclination to do things right, but he had a happy faculty of hatching up a pretty good scheme to get out of doing a job the way it ought to be done.

If a bolt came out of a fire door baffle plate, he would put in several seconds every time he shut the door, trying to get the corner of the baffle inside, when a new bolt and about 5 min. would have fixed the job right, and saved Sam a lot of wear and tear on his reserve force and religion.

Then, to go back to your oiling system again, as a sort of a text, I suppose that if you had it to do over again, you could make many improvements. This is but natural, for while any fool can improve it, it takes a genius to originate.

The first steam engines were very crude indeed and have been improved on by modern mechanics (some of them were fools and some were not) till they are very near perfection. Yet with all the skill displayed in the most modern steam saving devices, there are none of them that display the actual genius and brain power as did the first engines of Watt and Newcomen.

The first engines of George H. Corliss that were brought out when I was running, back before the war, were very crude,—but they delivered the goods. The genius was there, to furnish the necessary appliances for later minds to improve on.

Still, in this case, the rather terse maxim as cited above could not very well be applied, for there were, and are, some very brilliant minds engaged continually in improving the original Corliss principle. The brilliant and inventive minds of Edwin Reynolds, B. V. Nordberg, Pela Anderson, E. P. Baum, Frank Ball, George W. Melville (of the navy) and hundreds of more who through the irony of fate have been denied the fame that has come to some of the others, though equally brilliant, are continually planning, devising, contriving, experimenting, in order that they may be able to cut a quarter of a pound off the steam consumption.

Back in the old days, it was generally considered "good form" (as society women say) to have the stack belching forth as much smoke as could climb up the flue. The old timers (myself included) would look at a short stubby stack violating all the present day ordinances put together, and listen to the healthy exhaust of some new plant recently set up, and then exclaim:

"By cricky, old man Selfidge has got a fine engine there. He has, for a fact." Whereas, as a matter of fact, lap was a thing to be feared in those days because nobody seemed to know just what it was, and as valves were cast and made with a cold chisel, and not designed as at present, the terminal pressure was just as liable as not to be as high as the boiler pressure, and sometimes we believed it to be more!

The heat unit hadn't been born then, and if one were to mention "flue gas analysis," he would be examined as to his sanity. Steam consumption hadn't been invented, but if it had, some of those old time engines that I used to "run," and many another man like me as well, would have made the present day boiler feed pump look like perpetual motion.

I remember that a man's ability as a fireman was judged by the amount of smoke he could make, and the crude pictures that were printed then of plants showed a vigorous action on the part of the stack. Today, if the Chief catches a heat unit making its escape through a crack in the setting, he will simply raise cain about it, while the roofs of high buildings in town are liable to be covered with a delegation with smoke charts, cameras, stop watches, and other scientific instruments as well, and will soon let you know if you are violating "Article III., Section VII., Revised statutes of the current year," to the effect that, "If any stack, chimney or furnace, in the city of Podunkville shall emit, belch, vomit, produce, or cause to be produced, or emitted, dense black smoke, for a period not to exceed 1 min. and 15 sec. in any one hour," etc., etc., "$10 and costs."

Yes, Donny my son, while it may take genius to originate, yet it takes a lot of it also to improve, and to keep things so that they will be more susceptible to our will and serve the purposes of man. All of these things cost money. Anything worth while costs money (and lots that is not worth while, too), but if by spending some of the firm's money you can make money for the firm, then, Donald, you are beginning to be a real success.

Well, I wrote more than I really thought I could with my lame hand, but I got so interested in it that the pain went away. Mother is knitting you some more woolen socks. Well, my son, good night, and keep on the job with both feet. Love of labor is the beginning of prosperity. Mother sends her love.

Affectionately, your father,

Sandy MacDougal.

WHAT IS CLAIMED to be the highest head for a water power in the country is being developed at Belden, Calif., by the Oro Electric Corporation. This is on the north fork of the Feather River, and the dam will produce a lake containing 70,000 acre feet storage water, which will be conveyed through 3 miles of tunnel and 5 miles of pipe to the power plant, where it will be used under a head of current 110 ft., or over 900 lb. pressure to the square inch, developing 60,000 hp. total capacity.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

SETTLING CHAMBER FOR STEAM TRAPS

WE often read in engineering periodicals descriptions of various plants in which the fresh water is generally misused, whereas it could be used for increasing the efficiency in operation of the plant. The success of a combined power, heating and drying system depends on its intelligent design and proper selection of apparatus.

The reason for the general use of high pressure is the fact that a positive pressure is often required to render the apparatus effective, as the condensation must be removed as fast as it collects. High pressure is, however, not necessary as condensation can be more easily accomplished by the proper installation of a settling chamber, sometimes called a condenser trap, shown in the accompanying drawings.

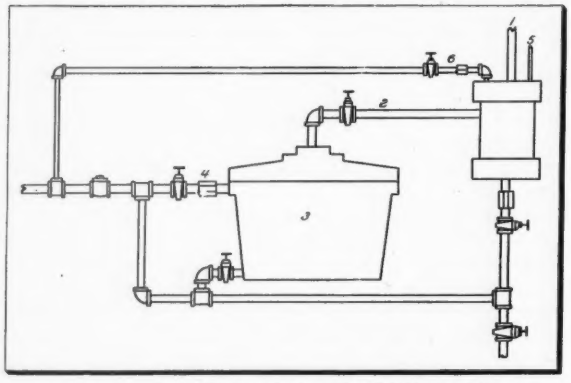


FIG. 1. CONNECTIONS FOR A CONDENSER TRAP

This chamber is intended to maintain an economic, serviceable, and efficient condenser in connection with steam traps thus forming a partial vacuum on steam apparatus, such as steam kettles, drain pipes from separators, steam heating plants, etc., which materially increases the evaporative efficiency and capacity of traps. This chamber also saves a great deal of trouble in preventing chips of iron, rust or scale from entering the traps and clogging up the valves and their interior mechanism preventing them from working properly. The chamber should be blown off frequently in order to keep it free from sediment.

The principal object of the settling chamber is to condense the steam and lessen the velocity of the condensation before changing its direction of flow and allow the heavier particles of dirt, scale, etc., to fall to the bottom, at the point where diverted.

The efficiency of a settling chamber of this type depends upon its size and is usually from 6 to 12 times the area of the inlet pipe, which greatly retards the velocity permitting the water to come nearly to rest and gives it sufficient time to settle. At the bottom of the chamber is interposed a baffle plate (shown in drawing), to deflect the sediment from flowing towards the exit pipe, causing it to drop to the bottom of the chamber, when the velocity is at its minimum.

Fresh water which is used in condensing the steam enters the condenser at 5 and from here flows by gravity into the receiver or open exhaust heater of the plant. The hot water service for the building is also in connection with receiver or open exhaust heater having a special pump for that purpose in supplying the building, as in this case a sufficient amount of cold water can be used for condensing purposes.

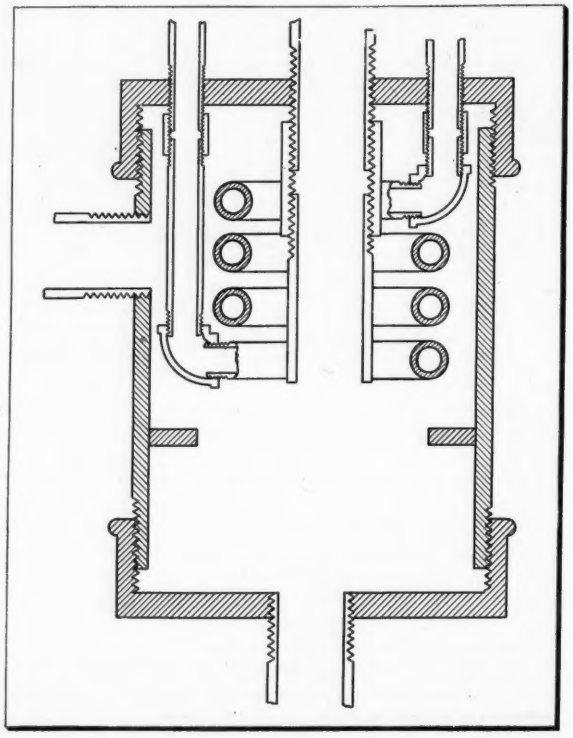


FIG. 2. SETTLING CHAMBER FOR CONDENSER TRAP

Lewis A. Danner.

DRILLING BRICK WALLS

WHEN it is desired to drill a hole in a brick wall, one generally gets a piece of pipe the desired size and with a hack saw and a file he soon has a drill that will cut the hole out in a very short time. But if more than one hole is to be drilled, the operator has to hunt up the hack saw and file again to make new teeth on his drill and so on till he has finished the job.

When you have another job to do, proceed to get your drill by cutting the proper teeth, smooth them up nicely with a file, then get a piece of cast iron (preferably round and the size of the inside diameter of the drill, so as to fit loosely), take it to the blacksmith forge, heat the piece of cast iron to a melting heat and the toothed end of the drill to a cherry red, insert the cast iron in the heated end of the drill and turn the pipe several times on the cast iron. This will rub off the melted cast iron on the the teeth of the drill. As soon as all the teeth become covered, pull out the cast iron and stick quickly into the stock tub. A chilled finish is then put over the teeth that can hardly be brazed with a file and will not break. When you are through drilling you have a drill that will be waiting for you on the next job. J. B. Linker.

HOME-MADE FEED-WATER REGULATOR

THE sketch illustrates a feed-water regulator which is giving excellent satisfaction on a battery of 500-hp. boilers. A plain 1½-in. globe valve with the stuffing box nut removed is supplied with a bracket as shown. We bushed the valve seat to 1¼ in. diameter and made a plain bevel plug to replace the disc to reduce the area to about 1¼ in. and lessen the pressure acting against the float. The stem need not be packed as it does no harm if some of the water is fed by the stem instead of the feed pipe—it all goes to the boiler. The valve need not be a balanced valve as there is but little difference of pressure on

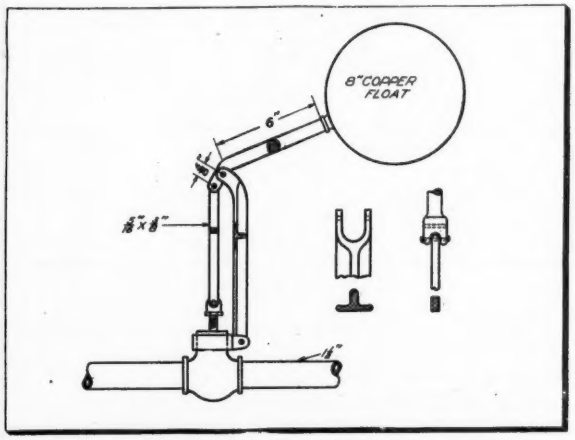


FIG. 1. FEED-WATER REGULATOR AND DETAILS

opposite sides of the disc—boiler pressure on one side, pump pressure on the other. Hence the float does not need to work against a heavy pressure as might be supposed without going into the matter.

It is readily seen that the leverage is increased enormously as the valve approaches the seat, at the same time the lift is large enough for full opening without much change in water level. Theoretically the float lever need not be so long as shown and at first we did put the float on a very short lever, but owing to scale deposits the valve would sometimes fail after several weeks service. The regulators that had been in the boilers had float levers about 2 ft. long with valve levers about 3 in. long, and used a balanced valve; and although the valve was put back of the baffle where the water is comparatively quiet, the valves continually chattered, also the arrangement was cumbersome and gave much trouble.

Before adopting the present arrangement, instead of the open bracket shown, we used a 1-in. brass pipe flattened and opened at the top to receive the float lever, and threaded at the bottom identical with the thread on the valve body, a coupling screwing on to both pipe and valve body. This placed the link and valve stem inside the pipe and made a good and solid device. The pipe, however, filled with scale in a short time rendering the valve inoperative. Cutting large slots in the pipe did not improve it much, and we had the cast brass brackets made as shown (making the patterns for all parts ourselves). The

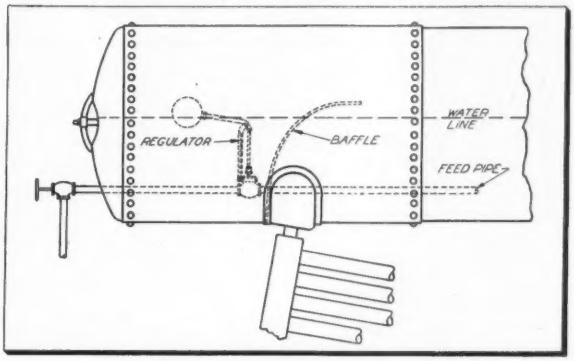
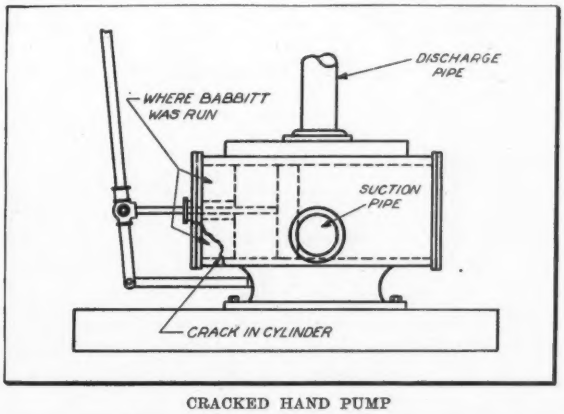


FIG. 2. LOCATION OF REGULATOR IN BOILER

bracket can be clamped for any float position and the lug and jam nut on the valve stem allow ready adjustment. It is understood, of course, that the valve must be mounted with the pump pressure on the bottom of the disc forcing the valve open, and that the feed pipe must be arranged about 12 to 18 in. below the surface of the water for a neat arrangement. Figure 2 shows the regulator in the front end of steam drum on the side of the baffle where the water is comparatively quiet. F. J. Schnaubelt.

REPAIRING CRACKED PUMP

IT became necessary at one time to fill an 80-hp. boiler that had been empty for several months. In hunting through the scrap pile an old hand pump was found such as is used to fill tanks, etc., but was found to have been frozen and cracked as shown in



CRACKED HAND PUMP

the illustration. The piston was left in cylinder but head removed and cylinder stuffed full of clay nearly up to the crack (cylinder having been set on end with cracked end up), then a space 3 or 4 in. around piston rod was filled with clay, so as to give room for rod

to move freely after babbit was poured. The space left was run full of metal up to and even with the head making a solid babbit ring inside of head of pump covering the crack in cylinder, after which the babbit was planed off even with end of cylinder and pump put back together. After which the pump was found to do the work of filling the boiler.

O. L. Harper.

IMPROVING THE TIME

WHILE running the engines in a sawmill, not being overburdened with duties, I looked over my "junk" one day and found an old steam gage with the center post bent. I took it apart, straightened it up, cleaned and oiled it, tested it out and found it in good condition.

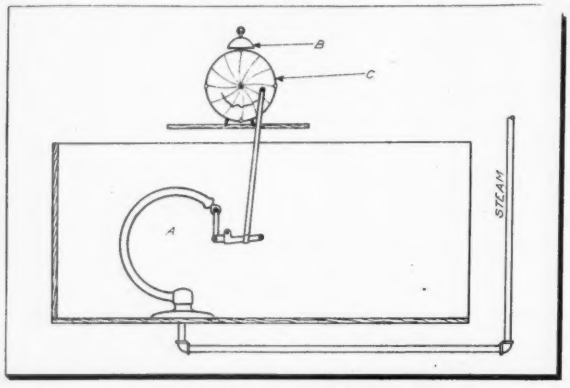


FIG. 1. HOME-MADE RECORDING GAGE

About that time an idea bobbed up and I proceeded to put it into effect. I got a piece of board 6 by 14 in. and nailed a strip along the bottom edge projecting one inch with a ¾-in. hole for the steam connection to pass through. Then removing the works from the case, I set the spring in place, discarded the center post, fastening the supports to the board in place so I could connect up the link. Taking a piece of tin ½ by 7 in., after bending the end out and into a tube

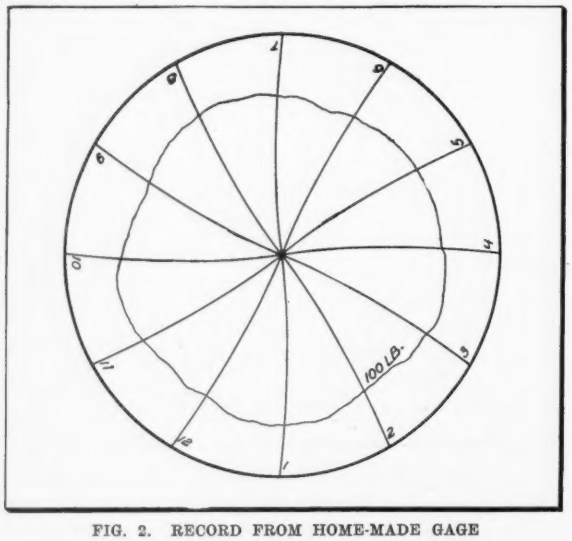


FIG. 2. RECORD FROM HOME-MADE GAGE

to hold a short piece of lead pencil, I soldered it to the quadrant lever so it would point straight up.

Then I rounded up an alarm clock, removed the hands and face, took the dial off the steam gage and soldered it onto the sleeve pinion that carries the hour hand. I set the clock on a shelf and by fastening a paper disk onto the dial with tin clips, it makes an amusing if not valuable adjunct to an engine room, situated as I am, out in the jungles. I can get a fair idea as to how the steam pressure ranges. It didn't cost a cent to make and I think my time was far more profitably spent than reading how Triangle Dick cleaned out a whole tribe of Redskins. N. W. Duell.

A SUCCESSFUL THERMOSTAT

ACCOMPANYING is a sketch of a thermostat which gives good results on a hot water supply system. Thermostat is located close to a heater and as the diagram is quite clear it will not need much explanation.

The water passes through the brass pipe and the temperature changes cause the pipe to expand or contract as the case may be. Suppose the water to be getting hot, the action will be as follows: The

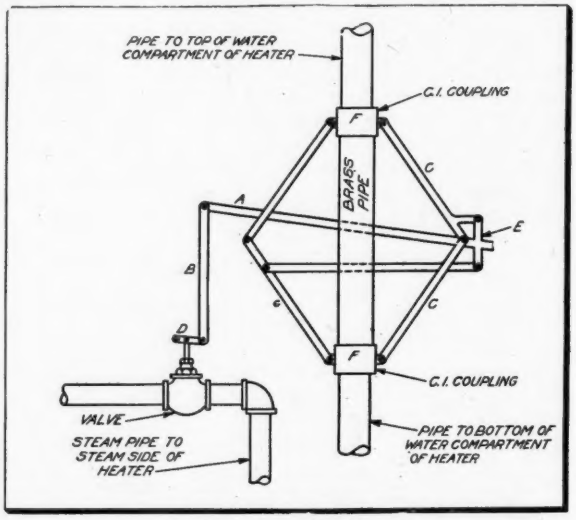


DIAGRAM OF THERMOSTAT

brass pipe expands, thus lengthening it and increasing distance between 2 cast-iron couplings F, F. As couplings move apart, rods CC and cc move in toward brass pipe in center, thus throwing lever down and closing valve by means of lever B and D.

Dotted line A is a lever passing back of other rigging and rigidly attached to link E.

Howard R. Taylor.

FEEDING UNDERLOADED BOILER

IN a certain plant the boiler feed pump was too large for the light night load and could not be run continually, hence the following expedient was successfully used. The hot water heating tank had a pressure of 140 lb. due to the head of water from the roof tank of the 20-story building, from the outlet of the hot water tank a 1-in. pipe was connected and run to a connection in the feed line to the boilers which were thus fed continually and the proper water level maintained; the regulator was set to raise the temperature of the water to 200 deg., exhaust from the engines supplying the heat to the hot water tank. The house pump was run about one hour at night to make up the deficiency of water in the roof tank.

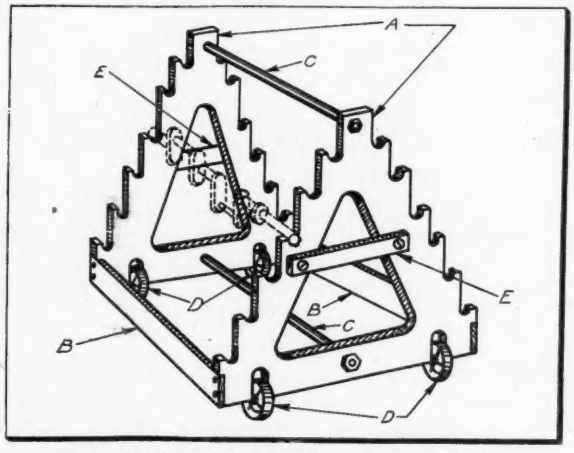
James G. Sheridan.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

FINISHED WORK TRUCK

ILLUSTRATION shows a home constructed truck. This will be very useful in automobile and machine tool shops where crankshafts and the like have to be moved from various departments before being completed. It is very essential they should not be damaged in any way. This device makes it possible to



TRUCK FOR CARRYING FINISHED RODS OR SHAFTS

handle conveniently the work and prevents damage.

It is constructed of 2 wooden end pieces A into which are cut the necessary receptacles to accommodate the ends of the shafts. These are braced together with the wooden struts B and the bars C. By the wheels D and the handles E the truck is easily portable.

C. F. George.

Electrical Troubles and Kinks

THE circuit breakers are of the single-pole type as also are the switches; the handles of the positive and negative knife switches come in close proximity to the circuit breakers. In cutting in an extra engine a sudden load from the elevators threw the circuit breakers just as the engineer had thrown in the 2 single-throw switches, which came on each side of the circuit breakers, and an arc from each breaker severely burned both his hands. This board is of late design but needless to say it was remodeled before a repetition occurred.

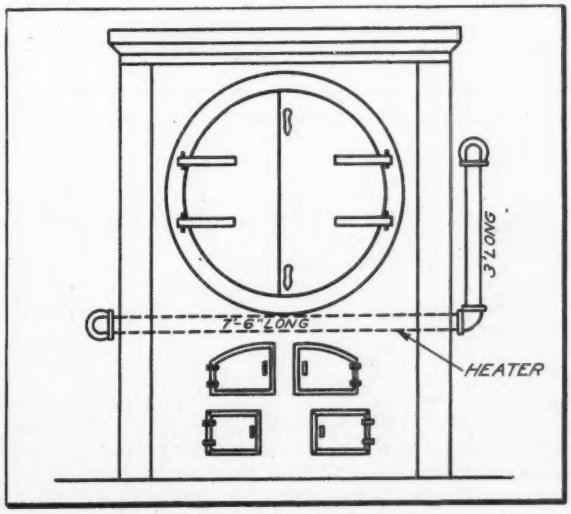
Considerable time and patience is spent by many engineers in spacing the brushes when they are to be reset, which should be done at more or less frequent intervals according to the wear or usage they receive. Usually the segments are counted and divided between each set of brushes, using a strip of paper cut the proper length to correspond to the distance between sets of brushes. The method in use by the writer is as follows: When the brushes are once accurately spaced and properly set a center punch mark is put in the end of the segment corresponding to the toe of each set of brushes which is used as a reference mark each time they are to be reset. The writer recalls a brush setting kink done by one of the utility men on an Otis elevator. The brush was of the plug type screwed into a socket, contact being made by the automatic switches. The threads, however, became worn from the brush and to secure it in the socket he had ingeniously wrapped it with sandpaper, thereby insulating the brush; this caused the writer no little inconvenience before the true source of trouble was discovered, as the insulation could not be seen.

Unnecessary expense could often be avoided when some of the more expensive fuses blow out, if instead of replacing the blown out fuse immediately with the regulation fireproof fuse, a lead wire fuse of equal capacity were used. If there is still trouble on the line the blown lead wire fuse cost but little and the trouble can be located and remedied before the original type of fuse is again put in, thus saving the expense of needlessly blowing more than one of the more expensive fuses for the same line trouble.

James G. Sheridan.

Water Heating Kink

ACCOMPANYING sketch is of a heater that I made. The feed water was cold that supplied my boiler so I cut a hole in the side wall at the front end just over the fire doors, just back of front wall close to



HEATING PIPE IN FRONT OF BOILER

boiler, and then I cut a hole in the opposite side wall for the end of the coil to rest upon as shown by the sketch. It took 6 1 ½-in. ells and 2 lengths of 1 ½-in. pipe, each 7 ft. 6 in. long and 2 pieces 3 ft. long. This size was most convenient for me, though I presume a larger size would work as well. I took water from a

reservoir at 60 lb. and fed it through the heater and to a receiver and then pumped into the boiler. There must be a continued flow of water or the pipes will burn. The coil will change the temperature from 40 to 130 deg. F., helps out in the coal bill and the firing is made easier. G. M. Brooks.

Manning Boilers

IN regard to the trouble F. D. Allen experiences with Manning boilers as related on page 426 of the April 15 issue of Practical Engineer, without knowing more about the operating conditions than is given, it is difficult to give a detailed answer as to the cause and remedy.

The writer has had considerable experience with this boiler, some of which has been pleasant and more otherwise. In the later design of Manning boiler as built by the Bigelow Co., numerous handholes are located to command the spaces between the several rows of tubes which make the cleaning of the crown sheets a comparatively simple matter. The handholes are arranged as in Fig. 1.

In this boiler, the crown sheet, lower ends of tubes and space over firedoor are the vital parts. In my experience I found that the scale adhering to the crown sheet would gather on the tubes something as in Fig. 2 for 2 or 3 in. above the crown sheet, with the result that the tubes started to weep.

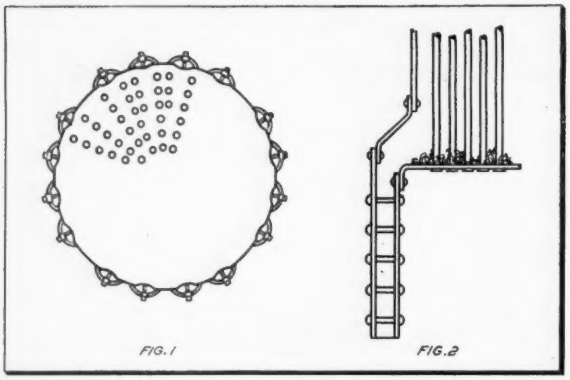


FIG. 1. ARRANGEMENT OF HANDHOLES FOR CLEANING CROWN SHEET
FIG. 2. ACCUMULATION OF SCALE ON THE CROWN SHEET

By blowing down the boilers every morning before starting the fires, considerable matter that would otherwise gather on tubes and sheet was removed. The handhole plates were removed every 10 or 12 days, and a scraper introduced to clean the portion of each tube that could be reached and the crown sheet.

A small hoe was made that would move freely between the rows of tubes and the deposits drawn to the handholes when the hand or small shovel with sides removed the scale. A hose was then used and washing continued until the water ran off practically clean without discoloration. The deposits that lodged or dropped down the water leg onto the ring uniting the inner and outer sheets remained.

In many cases where the water is bad, the Manning boiler does not give trouble when there is sufficient time for cleaning. The upper tube ends, paradoxical as it may seem to many, gave me no trouble whatever.

In one plant the fireman was in the habit of crowding the fire, then letting it practically die out, which, with the habit of leaving the fire door open more than necessary, caused numerous leaks; and after the tubes were expanded 3 or 4 times, they were so thin that they had to be replaced.

In putting in new tubes they should always be beaded as it adds considerable to their holding power and does not leave the joint, the end of the tube, open to the action of the gases as much as when the tube is simply expanded.

When the boilers are of moderate or large sizes, they are usually stoker fired, and in such cases the firebox temperature is higher than when hand fired and especially so when the boilers are forced. Trouble developed in one plant with which the writer was connected, the boilers being the standard type of the builder for that size unit. They were mounted on a Dutch oven and over a well known make of stoker.

I came to the conclusion that the heat was so intense that the crown sheet could not transmit it without causing leaks around the tube ends. By crowding any of the other boilers and relieving any one of the others to a little less than rating, the trouble disappeared.

Soon it became necessary to enlarge the plant and owing to floor space available, vertical boilers were the solution.

After talking with the boiler insurance inspector, we succeeded in having the water legs of the new boilers made 2½ ft. larger than the older boilers and, when set over a furnace of the same height as the others, fired by same stoker and driven above rating, developed no trouble. Mr. Allen can think this over.

For the benefit of R. Prior on the same page and issue, will say that I do not consider it practical to attempt to make a siphon condenser or injector from pipe fittings. To obtain satisfactory operation, the parts must be accurately designed for the service.

A small deviation one way or another will have a marked effect upon the results of the apparatus. And even if one makes these more or less trouble would naturally result, owing to the whole being a makeshift at best, the better way being to purchase them from reliable manufacturers who will, of course, guarantee their satisfactory operation. Receiver.

Boiler Trouble

AFTER reading about Mr. Allen's trouble with the Bigelow-Manning fire-tube boilers, I should judge his trouble is, most likely, with the top head, as the steam is nearly dry and burning wood allows an intense heat directly into the tubes and on all upright boilers of this type which have a large steam space, the tubes get overheated; also, a smokestack too small will aggravate the case. I would try ferrules to protect the ends of the tubes. Having had some experience in erecting and repairing this and other types of boilers, I have always found mud or scales to be the cause of bottom end leaks. Use the best of Reading charcoal iron tubes. B. C. White.

THE BOILER INSPECTORS of Ohio have formed the Ohio State Boiler Inspectors Association, with M. T. Slattery as President, T. F. Meyers, Vice-President; F. P. Somers, Treasurer, and Art. F. Graham, 1379 E. 91st St., Cleveland, as Secretary. The Association has been in operation for some time, but has not yet secured charter, and for the present is meeting on the second and fourth Tuesdays each month at Cleveland. Other information can be secured from the Secretary.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Flow of Water over Weir

I AM figuring on the power required to pump considerable quantities of water by Diesel engines using California crude or fuel oil. I have a system of figuring but the results of cost are so low that I am inclined to doubt my own figures. Will you please give me a plain formula showing how to obtain the horsepower required to lift a certain quantity of water a certain height within a certain time, also the efficiency of centrifugal pumps so as to obtain a reliable estimate of the power required to irrigate land with certain quantities of water. In order to obtain as near a quantity of water by pumping as is furnished by the water company, I must know the quantity they are furnishing. There is no way for me to find this out other than to figure how much water will run through an opening 6 ft. long and 6 in. high without head, the water running over a board as illustrated. Ditch has about 1 in. fall in 100 ft.

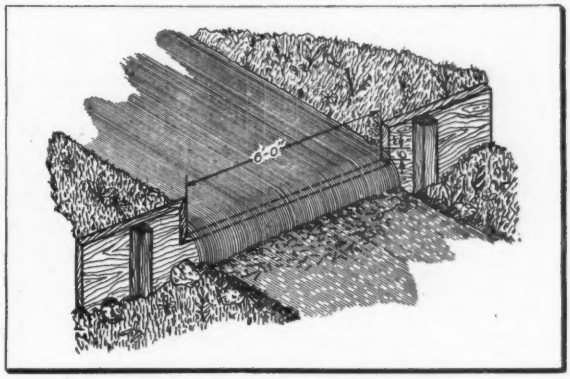
How much water would run down if the stream is 8 in. deep? How much if the stream is 10 in. deep? I cannot measure the flow in the ditch as there is none now and will not be for some time. U. B.

A. The rate of flow of water measured over a weir of the same width as ditch, with no baffles to destroy "velocity of approach" to weir, is quite unsatisfactory, and an error of 20 to 50 per cent is easily possible.

In cases where the flow is more than 200 miners' inches, as in the example, and where the usual weir with dimensions largely in excess of ditch dimensions is not available, select a straight course as much over 100 ft. long as is possible; determine the velocity of flow in feet per second by the use of a stop-watch and a float more than ¾ as wide and about ¾ as deep as the ditch (assuming the ditch to have a rectangular cross section, as is intimated in data given). A circular float with downward projections, 2 in. by 2 in. by ¾ of depth of water is best. Velocity in feet per second multiplied by the average area of cross section of ditch in feet, will give the rate of flow in cubic feet of water per second, from which the flow in acre-feet or miners' inches can be calculated.

The efficiency of centrifugal pumps of modern make, operated at speed and load designed by maker, is often as high as 85 per cent. Their efficiency falls rapidly with the increase of friction in piping system. See Weston's "Friction of Water in Pipes." Catalogs furnished by pump makers all give complete data as to duty the particular make and size will perform, and may be relied upon. Such catalogs also contain valuable rules and formulas regarding irrigation problems and may be had by mailing address to makers, with postage.

In figuring irrigation requirements in California, the character of the growing crop should be stated. Between a minimum requirement of 245,000 gal. per acre, carefully conserved, for a field crop or deciduous fruit trees, and a maximum of 1,000,000 gal, per acre per annum, as practiced by some citrus growers is a wide margin, but these figures may be taken as low



VIEW OF WEIR FOR MEASURING FLOW OF WATER

and high requirements, the former representing about 9 in. of rainfall in quantity, but rather more than that amount in efficiency.

Starting Power of Single and Double Eccentric Engines

TWO Corliss engines are identical in every respect, as to size, speed, etc., except that one has but one eccentric, while the other has 2, one each for the steam and exhaust valves. Which engine will have the greater power in starting? S. M. M.

A. A Corliss engine equipped with but one eccentric has a limit of cutoff of about 45 per cent of the stroke, depending somewhat on operating conditions. An engine of this kind has considerable lap in the extreme position of the valve and as the eccentric has to operate the exhaust valves also, the angle of advance of the eccentric must necessarily be such as to operate the latter at the proper time to secure the proper release and compression.

This angle of advance will usually be about 105 deg. ahead of the crankpin (with a direct motion from the eccentric to the valves), which will bring the reciprocating parts to a position somewhat less than half the stroke when the eccentric is passing the center.

On a single eccentric standard Corliss engine, however, as soon as the governor drops so far that cutoff cannot occur, the disengaging device becomes inoperative, and the valves are carried throughout the stroke, when we have to all intents and purposes, the same action as we get with a common D slide valve, until such time as the load changes enough so that cutoff by the usual method can take place.

It can thus be seen that when the eccentric has passed the center and the "carried" steam valves are beginning to close, the steam entering the cylinder is throttled more and more as the valve closes so that the terminal pressure is as low as it would be with an engine of the same dimensions having a common D valve.

On a Corliss engine having a separate eccentric for the steam and exhaust valves, the exhaust eccentric has practically the same position as has the eccentric on a single eccentric engine, while the steam eccentric has a position considerably behind, owing to the fact that on this type of engine, the lap is very small and the eccentric does not have to move the steam valves very far before admission takes place.

Consequently, as this angle of advance is small in the neighborhood of 35 to 40 deg., it can readily be seen that when the steam eccentric is passing the center, the position of the reciprocating parts is at approximately 75 to 80 per cent of the stroke.

But on a double eccentric engine, if the valves were carried when the governor was in the lowest position, it would be impossible for them to close before the exhaust valve at the operating end had opened to release the steam, with a consequent loss of steam. So it is arranged that the valves are never carried at any time and as soon as the engine starts, cutoff takes place, but it takes place quite late in the stroke. Thus it is that steam is admitted at full pressure for about ¾ of the stroke when double eccentrics are used and the terminal pressure under these conditions is higher than is the terminal pressure of an engine with a single eccentric and carrying the valves.

Consequently, if it were possible to apply a load that would tax the capacity of an engine in starting, the engine equipped with a double eccentric would start a greater brake load than one with a single eccentric, other things being equal. If, however, it is simply a case of having the crankpin in a position where the most leverage could be applied, and it was desired to demonstrate which engine would overcome the greater resistance, or torque, other things being equal, there would be no difference between the 2 engines as both have the same dimensions and the same pressure. G. H. Wallace.

Designing a Link Valve Motion

IF the link on a link motion engine should become destroyed so no measurements could be taken, how would you determine the length for a new one?

J. A. Rounds.

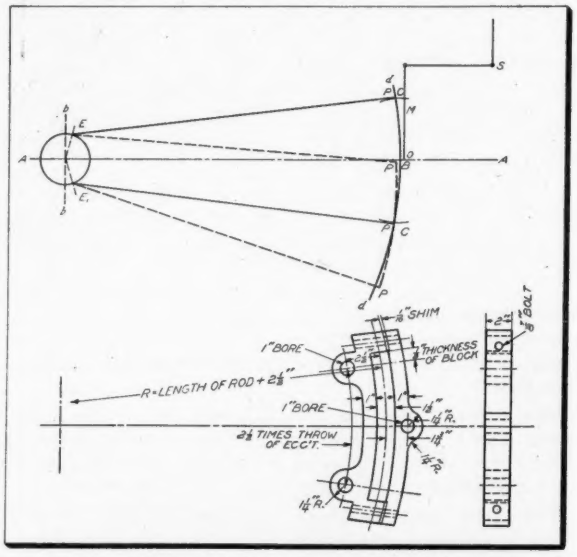
A. It would be necessary to design a new one to fit the conditions. To design correctly the whole valve motion is a complicated piece of work, but with the full gear to work from it is an easy matter to supply one part.

This may be done by simple diagrams as shown in the accompanying illustrations. Draw the center line A A also the line b b. Lay off the eccentric circle with a diameter equal to the throw of the eccentric. On this circle locate approximately the position of the center of the eccentrics E E_1. Then with the compasses set to a radius equal to the distance from the center of circle E to the center of the link block when it is in mid position, strike an arc, d d, then with a center, B, in line A A and arc d d and a radius equal to 1¼ time the throw of the eccentric strike arcs C C cutting arc d d as shown. The line P P is the arc of the link.

The position of the link in full stroke position is shown dotted. The link pins P P, to which the eccentric rods are connected, are set back from the link arc, and the slot must be long enough to allow the link to move over the block B far enough to bring the center of the pin over the center of the block, in which position the valve is controlled almost directly by the eccentric E. The link is suspended from the hanger M and reverse shaft centered at S. The hanger is connected to the saddle pin O on a plate that is usually at the middle of the link.

The distance between the link pins is usually not less than 2½ times the throw of the eccentrics. If the distance is less than this amount, the angle between the link and block will be so great that there will be excessive slip on the block, and undue stresses in the mechanism will be induced.

The location of the saddle pin is important, as the cutoff is changed, it is desirable to maintain an approximate equal cutoff at each end of the cylinder. This can be secured in the Stephenson gear by properly locating the saddle pin and the reverse shaft. When upset to drive a valve without a rocker arm the saddle pin should be a little ahead of the link center towards the valve or on the convex side. And when used with a rocker the saddle pin should be placed on



LINK VALVE GEAR DIAGRAM AND APPROXIMATE DIMENSIONS

the concave side of the center line. This will give equal cutoff between the 2 ends, and equal lead at all points of cutoff. The saddle pin should be placed equidistant between the link pins to give symmetrical action to the valve for both forward and backward stroke. The slot in the link should be long enough to allow the center of the block to come in line with the center of the pin at full stroke.

With this information the link can be laid out. The length of the slot should be made 2½ times the throw of the eccentric plus the thickness of the block, and the link pins one-half the thickness of the block from the end of the slot, the saddle pin is placed one-half the width of the slot from the center line, and midway between the pins. The other dimensions will be determined by the size of the block, and other conditions taken from actual measurements. The dimensions placed on the drawing are merely to give a general idea of the proportions of each part, and in designing a link for a given engine will necessarily be governed by the existing conditions. J. C. Hawkins.

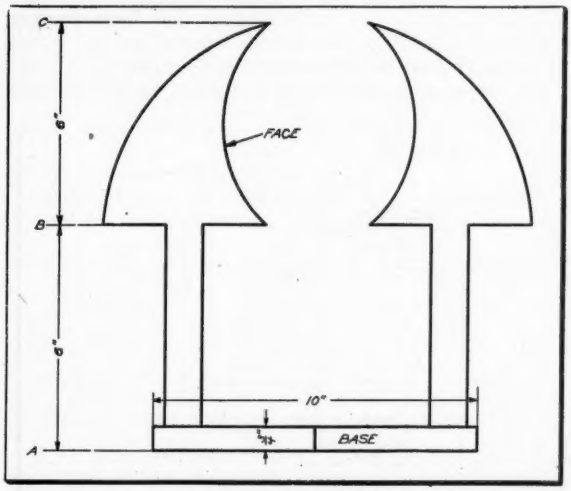
Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Magnet Problem

I SHOULD like the solution to the following problem in magnetic circuits:

Cross-section of core A to B = 1 sq. in.
Cross-section of magnet face = 10 sq. in.
Length of curved face = 5 in.
Width of curved face = 2 in.
Base = ¾ by ¾ by 10 in.



MAGNET DIMENSIONS

What is the reluctance of the several parts: A to B, B to C, and base? L. K.

Shutting Down a Boiler

IN reply to the several questions asked by Subscriber on page 337 of the March 15 issue of Practical Engineer, I offer the following:

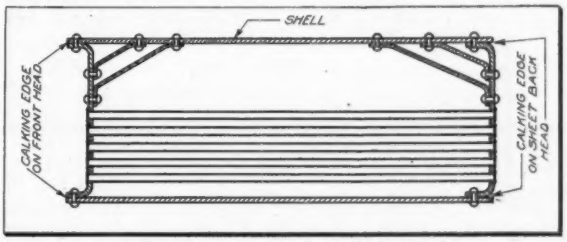
As to the manner in which to proceed to cut in a boiler or shut it down, it depends to a certain extent on conditions. For instance, suppose the boiler is one of a battery of several all connected into the same steam mains and the blowoff pipe burst, the manner in which the boiler would be cut in would be different from the usual conditions when the boiler is to be laid off for repairs or not required to handle the load.

If the blowoff pipe burst and the boiler was fitted with stop valve of the modern non-return pattern, as soon as the pressure dropped, due to the liberation of a portion of the boiler contents, the non-return valve should close, thereby effectually cutting out the boiler from the steam main. If the main stop valves are of the common type then they must be closed by the attendant.

In many cases the contents of the firebox will be thrown out into the boiler room, making it impossible to get to the fire doors, but as the bulk of the fire has been removed from under the boiler the intense heat is also removed until such time as the way can be cleared to enable the attendant to draw the remainder of the fire or cover it, as circumstances dictate. Some would advocate increasing the rate of feed, others let the feed-water supply remain as it is.

If the boiler is to be laid off under normal conditions, proceed to burn down the fire, and remember that it is quite a knack to burn down a fire properly, that fuel can be added to advantage and the whole completely burnt.

After the fire is burned out fill the boiler to the top gage cock and close the main stop valve together



METHOD OF RIVETING BOILER HEADS

with whatever main valves are provided to drain the header. This is under the supposition that the boiler is one of a battery.

If a single boiler, the steam pressure will fall due to less intensity of the fire and when down to 30 or 40 lb. shut the stop valve. This is the manner in which many men operate single boilers, closing the main stop valve each night and Sunday.

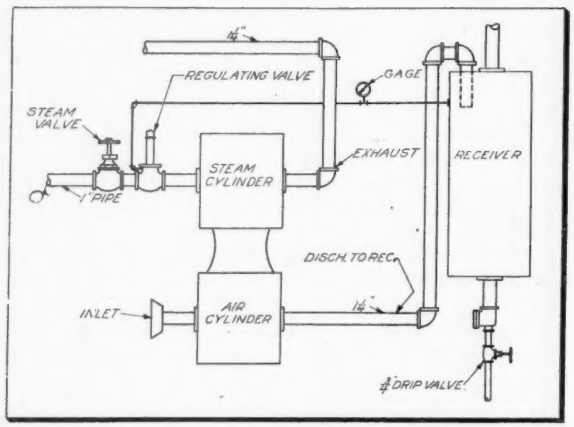
2. By reference to Fig. 1 it will be seen that the port head is so located inside the shell plate that the head flange points outward to enable the edge of the flange to be properly calked onto the shell plate to make a tight joint. With the back head the edge of the sheet is calked onto the back head flange to accomplish the same ends.

3. Should the fusible plug let go, cover the fire with coal, which is usually handier to get than ash, open the dampers in the uptake and chimney, keep other doors about the setting closed, because the desire is to reduce the heat and so prevent overheating of the upper row of tubes and the manner named will accomplish it in the shortest time. The steam pressure is of little consequence because it will only whistle through the burnt plug and do no harm, while the heat should be reduced as mentioned at once.

4. In regard to a handhole or manhole plate falling in with pressure on the boiler you are correct, that is a catch question only. Many times we see manhole and handhole plates weep or even leak a stream when no pressure is on the boiler but are absolutely tight when under pressure. It is a good idea to take up on the bolts on both when the pressure is down, to stop such weeping if it can be done and not over strain the bolts. Receiver.

Air Compressor Problem

THE trouble with E. S. R.'s compressor and piping, in March 15 issue, is all in the piping of the receiver. All air contains more or less moisture, for convenience we will assume one per cent in this case. If 75 lb. is carried in the receiver the compressed air would contain 6 per cent moisture, a part of which would be condensed on the inner surface of the receiver, due to the air of the room being colder than the air in the receiver, which is heated by compression and will collect at the bottom of the receiver.



PROPOSED PIPING FOR AIR RECEIVER

But as E. S. R.'s receiver is piped in at the bottom, the moisture is picked up and thrown upward, caught in the current of outgoing air, and carried along through the pipes. If the piping is changed as shown by dotted lines, the moisture will collect at the bottom of receiver and remain until drawn off at the drip; the receiver will act as a separator, and the compressed air will be dryer than the air in the room where the compressor is located. J. R. Morton.

IF E. S. R. will pipe his discharge from air cylinder with the side of reservoir 1 ft. or more above bottom he will no doubt be rid of his trouble. As it is, he is drawing straight through and his drain is of no use Leave ¾ drain in the bottom as shown and connect discharge as above. His so-called regulating valve is in fact the pump governor. The location of his pump is all right. We have one pump in the basement and by blowing out the tank after using it we never have any trouble with water. J. C. Lee.

Heater Piping

TO correct the heater drip shown in the March 1 issue, a 2½-in. hole should be drilled in the base of the heater, and a 2½-in. flange tap bolted on, making an independent drip of it.

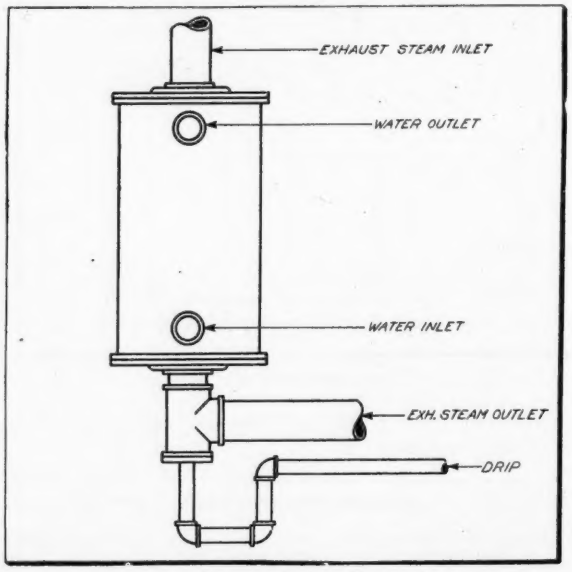
I have installed a number of heaters in different parts of the country and in 2 cases this same problem was met, for these reasons, the heaters come with no provisions made for drainage, and the heads of both concerns could not be made to believe that a second hole was necessary for draining, but will state that after spending considerable money experimenting, the drain was put in the base of the heater where it belonged.

If it is not possible for you to drill the base of heater, you will better the present condition by taking the 6-in. ell off directly under the heater and replacing it with a 6 by 2½ by 6-in. tee, then come down and swing into your 3-in. line with a 90-deg. ell about a foot below the 1-in. drip inlet thus reducing the friction on your drip water. I should strongly advise drilling the heater, however, thus giving you better feed-water temperature, which represents coal. L. E. J.

ON page 286, March 1 issue of Practical Engineer, A. J. has some trouble with a closed feed-water heater, and I think the cause is very plain, that it will not drain as he says. In the first place a closed heater acts the same as a condenser, except for the air pump and according to his sketch there is no way for the heater to drain, for the force of the steam entering at the bottom of the heater keeps the water from dropping down through the exhaust pipe to the drips, so the drips get only the condensation from the pumps and exhaust pipe from his pumps.

I should advise A. J. to put his exhaust in the heater at the top instead of the bottom and his drips at the bottom, and I think his trouble will be over.

Accompanying diagram of a heater I have in service



HEATER PIPING PROPOSED BY G. S. V.

shows connections; it is giving excellent service. I am feeding 4 300-hp. boilers through it with a power pump driven from the line shaft, and put the exhaust from 2 engines through it, one 100-hp. and one 300-hp., with the 100-hp. engine running alone. The heater condenses all of the exhaust steam and as it exhausts to the atmosphere there is no back pressure, so in place of putting a trap on drip from the heater I put a 1½-in. pipe with a U bend so as to hold the steam back in the exhaust pipe. This drip pipe gives a full stream all the time to the hot well and my feed water from the heater varies from 170 to 190 deg.

I am convinced that the only proper way to pipe up a heater of the National type is to take the steam in at the top and out at the bottom, and the cold water in at the bottom and out at the top, for the simple reason that the cold water enters the coolest part of the heater and rises to the hottest part. G. S. V.

Re-fluing Boilers

IN replying to J. E. M.'s question on re-fluing a boiler I will give my idea as it might be of some benefit. In re-fluing be sure, in taking out old flues, not to mar up flue sheet very much or it will spoil the contact for new flues. The best way is to cut old flues off with a cutter and remove them through the handhole in the front head, but if there is none you will have to work them out through the flue hole by chipping off the head and making 3 or 4 cuts in the end with a cape chisel so as to reduce it in size by collapsing and then working it out.

In putting in new flues be sure to have the end of flues clean, also flue holes. The tube should extend 3/16 in. beyond the tube sheet for bead, Fig. 1. If tube hole is a little large a copper ferrule is a good thing. The ferrule should be expanded in before tube is put in. In some boilers the hole is a trifle smaller than tube at firebox end and the tube needs swedging down to drive it in place, so after expanding, the tube is the same thickness as originally. Expand the tube at both ends and then hammer over for bead, expand again but be careful not to expand too much; now use the beading tool with medium blows so that the bead will lie tight to flue sheet.

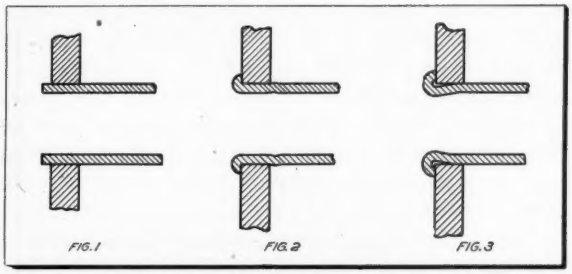


FIG. 1. TUBE IN PLACE, NOT BEADED FIG. 2. PROPERLY BEADED TUBE ENDS FIG. 3. IMPERFECT BEAD

The Prosser and roller expanders are both good but I prefer the former for new work. The flues do not need beading in smoke box end as they seem to hold equally well without, as in Fig. 1.

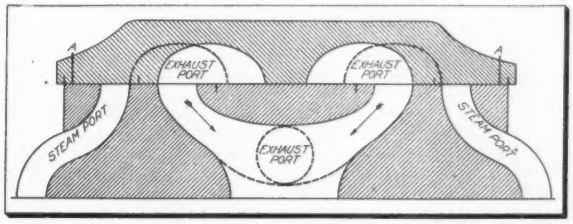
Be sure not to leave too much for bead as it will leave the end like Fig. 3, instead of Fig. 2 as it should be. The Prosser expander leaves the flue as illustrated in Fig. 2. In using the pin is driven in fairly tight then jarred loose and turned around partly and continued until a tight joint is secured. With the roller, the pin is driven in and then turned and rolls the flue out.

Valve Problem

IN the Mar. 15 issue, E. H. Lewis gives us a problem under this head to which this is an answer. He does not give clear information which would aid us to check off the amount which he says the valve should have taken off each end. If his sketch is drawn to exact scale then he has too much lap, both exhaust and steam.

Throttling engines with simple slide valves generally cut off at 75 per cent of the stroke. Allowing that this is true, then this sketch is not properly proportioned. The steam lap should equal the width of the port. For accuracy, Mr. Lewis should have given width of the ports and laps in inches.

Judging from the proportions of his sketch, the valve may be so made as to use steam more expansively than it would if cutting off at 75 per cent of the stroke. For instance, he says that the valve has 4-in. travel, and as the travel of the valve equals 2 times the width of the port and lap, taking his sketch and proportions, then the width of the port must be less than the lap.



PROPOSED CHANGE IN VALVE PROPORTIONS

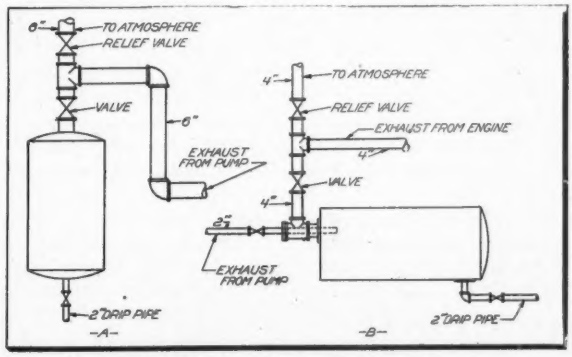
This leaves this important point unsettled, for the port may be only 7/8 in. or 3/4 in. in width which would give an earlier cutoff and later release with earlier compression.

Again, referring to the 4-in. travel and assuming that the engine was originally cutting off at 75 per cent of the stroke, then the width of the port must be 1 in. and the lap should be equal. Using his sketch for illustration, we would then find that he must have the outside edges to the lines AA. They would then overlap the port the distance of its width. Making the lap equal to the width of the port under these conditions will give a cutoff at 12-in. stroke and add power to the engine.

The exhaust lap is also too excessive; in fact, with this type of engine and valve there will be no necessity of exhaust lap, and the exhaust chambers in the valve should be approximately as shown by the dotted lines of this sketch. If this sketch shows true proportions, then the engine must have excessive compression which retards its action. Hubert E. Collins.

Heater Piping

ANSWERING the inquiry of A. J. in March 1 issue of Practical Engineer regarding his heater I send 2 sketches of piping. Figure 1 refers to his heater and Fig. 2 is a horizontal heater which we have in use at our plant and it works all right, the principle is about the same. If A. J. will cut out his present drip pipe and put in one large enough to take care of all



HEATER PIPING PROPOSED BY P. H.

condensation of his 4 pumps with a valve so that he can regulate the discharge when he has only 1 or 2 pumps running and then changes his exhaust pipe so that the exhaust steam enters at the top with a valve between the tee and top of heater, and a relief valve in the atmospheric exhaust line, he will have no further trouble. P. H.

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CAPITAL—LABOR

In the mass of discussion and assertion on these 2 topics where so often and so unfortunately the phrase "capital versus labor" is used in a way to insinuate that there is a natural and unavoidable antagonism, it is refreshing to note the broad view of Hon. William B. Wilson, Secretary of Labor, as expressed in a recent interview; a view so just and logical as to warrant the devoting of editorial space to his message of purpose. Coming from one who has risen through labor to a post of high responsibility it is worthy of careful attention by all who labor or who have capital invested, and this, on consideration, will leave only the vagrant class as uninterested. The quotations are from The Nation's Business published by the Chamber of Commerce of the United States of America, and are replies to questions by the editor of that paper.

Mr. Wilson said:

"Capital and Labor are partners. The Department of Labor is to prove a promoter of industrial peace. Our duties are assigned to us in the organic act. But one of these duties, namely, 'promoting the welfare of the wage earners of the United States,' is so general in scope that it will very naturally lead to several lines of endeavor not now anticipated. Our right to act as a mediator in labor disputes and to appoint conciliators, if I may so describe them, makes me feel that the Department of Labor is intended to promote industrial peace.

"Capital and labor are partners. Capital without labor is ineffective. Labor without capital is idle. Capital is an inanimate thing. It represents the accumulation of the unconsumed product of previous labor. On the other hand, capital is the means by which labor can live until the products of its efforts can be realized on. Capital, the inanimate thing, can produce nothing except by providing opportunity for labor. Therefore, capital and labor to be effective, must serve each other.

"This leads naturally to an important statement, the force of which is sometimes overlooked. As capital and labor each must serve the other, then each must have voice in determining the terms of partnership. It is here that we have had trouble in the past. In our disputes we have confused the meaning of the words 'mutual' and 'identical.' The interests of capital and labor are mutual—they are not identical. They are mutual in seeking the greatest production by the expenditure of a given amount of effort. It is only when it comes to a division of what has been produced that their interests diverge.

"As I see it, the average thinking man, who contemplates for a moment the difficulties under which labor has carried forward its task in the past, would concede the truth of the general statement 'every man is entitled to the full social equivalent of what he produces.' The problem, however, is to arrive at that figure, and it is in such direction that conciliation and discussion will render their great services. Let me

illustrate the problem by drawing attention to a finished locomotive as it stands on the rails ready for service. That locomotive is the collective result of the activities of nearly all elements of organized society. The man in the ore beds, the miner of coal and producer of limestone and feldspar, only touch the side of the raw material. The organized efficiency of the blast furnace, the intricate labor of the foundry, the vision of the inventor, all find a meeting place in that construction of mechanical skill. But I have not touched at all upon the interest of the educator, of all those along the way who had to do with the labor of production. I have not referred to the minister who looked after the spiritual interests of all those who had any task to perform in connection with this finished product. When all these are included, I still have made no reference to the farmer, who through his performance of social duty, has rendered it possible for those who labor in mechanical lines to live on food raised far outside their home town. Then as the link of all these apparantly unrelated activities comes our transportation system. How can it be possible for us to blind our eyes to the fact that every finished product is the result of an interplay of social functions, touching every phase of society? Thus arises the complicated question as to what is the full social equivalent of what a man produces.

"The modern industrial method is too complicated for any man or set of men to decide that a solution of all trouble has been found. Therefore, I look forward over the future of the Departent of Labor as a means of helping to bring nearer year by year the goal of complete social justice. This surely must be the ideal of those who regard humanity as something too sacred for selfish exploitation.

"What I have said relative to the locomotive as a type illustrative of the activities necessary to produce one result, leads me to state most emphatically that labor is the producer of all wealth, but to add with equal emphasis that muscular labor is not the only form of labor. The influence of the mental concept must not be lost to sight; the productivity of labor as effected by management; the foreseeing of a machine in the mind of the inventor; all these things it seems to me represent labor.

"One of the greatest services that can be rendered by the Nation to labor of the muscular kind is in the direction of efficiency and that is why during my Congressional life I gave whatever support I could to the subject of vocational education. I am glad to see that the Page Bill has been reintroduced and to know that the friends of vocational education are striving to bring into it some changes that may produce prompter action on the part of Congress. But whatever Congress in its wisdom may do, the fact remains that the greatest strength to come to our nation is in the direction of efficient life on the part of the majority. Our high schools are producing students for colleges and for professional life. They are only a small proportion of the student force of America. Those who do not reach high school are the vast majority. It is of that vast majority that society must think in order that the lives of the many may become efficient. I strongly favor federal funds being placed at the disposal of those states that will contribute similar funds to produce an educational change which is essential, now that our nation has taken on a distinctly manufacturing type of development.

"As one who came to America in childhood, led by parents who saw in America a land of hope, I share in common with others some apprehension at the apparent loss of simplicity in our national life. Yet I must hold to the hopeful belief that ultimately there will be restored to this country some of the simplicity that once characterized it and which preceded our artificial lines of social cleavage. We gain nothing by the separation of classes. We lose the common touch. I am confident that simple democracy will increasingly commend itself to American thought as a means of holding us together as a Nation, strong in our respect for mutual rights and for individual hopes."

INTERNATIONAL ENGINEERING CONGRESS, 1915

IN connection with the Panama-Pacific International Exposition which will be held in San Francisco in 1915, there will be an International Engineering Congress, in which engineers throughout the world will be invited to participate.

The congress is to be conducted under the auspices of the following 5 national engineering societies: American Society of Civil Engineers, American Institute of Mining Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and The Society of Naval Architects and Marine Engineers.

These societies, acting in cooperation, have appointed a permanent Committee of Management, consisting of presidents and secretaries of each of these societies, and 18 members resident in San Francisco.

The committee has effected a permanent organization, with Prof. Wm. F. Durand as chairman, and W. A. Cattell as secretary-treasurer, and has established executive offices in the Foxcroft Building, 68 Post Street, San Francisco.

The scope of the Congress has not as yet been definitely determined, but it is hoped to make it widely representative of the best engineering practice throughout the world, and it is intended that the papers, discussions and proceedings shall constitute an adequate review of the progress made during the past decade and an authoritative presentation of the latest developments and most approved practices in the various branches of engineering work.

The papers, which will be collected and published by the Congress, should form an invaluable engineering library, and it is intended that this publication shall be in such form and at such cost as to become available to the greatest possible number.

The various committees are now actively at work, and it is hoped that further and more definite announcements as to the membership fees, schedules of papers, etc., can be made in the very near future.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

WATERPROOF WOOD CASINGS

IN all cases where steam or hot water is to be conveyed for considerable distances under ground, it is desirable to have a casing protection over the steam pipe, which shall prevent loss of heat and also corrosion of the pipe.

Selling of steam from a central station to the residences of cities is successfully established as a profitable undertaking, and such sale means the installation of a system of distributing pipes which should have satisfactory protection. For such service, the stave casing, made by the Michigan Pipe Co., of Bay City, Mich., has been designed and offers a satisfactory solution to the problem. For pipe up to 6 in. in diameter, solid casings are furnished if desired, these being made by boring logs which are afterwards sawed in halves, and covered with a protecting coating of creosote preparation, which in turn is thoroughly filled with a sawdust veneer.

FIG. 1. THE MICHIGAN CASING, PARTLY IN SECTION TO SHOW CONSTRUCTION

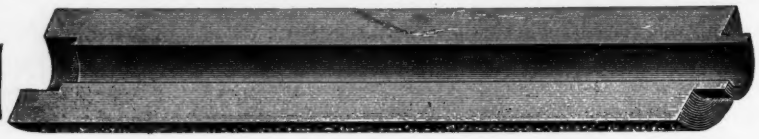


FIG. 2. SECTION OF SOLID CASING AS USED FOR PIPE 6 IN. AND UNDER

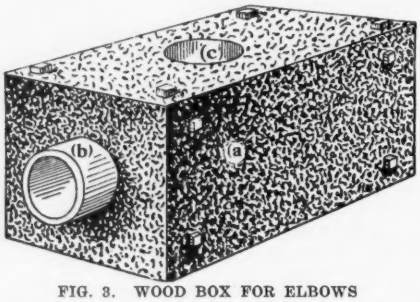


FIG. 3. WOOD BOX FOR ELBOWS

For the stave casings, the length is 12 ft., the material being Michigan pine or tamarack, with inner and outer surfaces of the staves shaped to conform

FIG. 5. GUIDE FOR HOLDING PIPE CENTRAL IN CASING

to the inside and outside curves of the pipe and with the sides having double tongue and groove running the full length of a casing section.

After assembling in a cylindrical form, the sections are wound spirally with 3/16-in. galvanized wire from end to end, under heavy tension, a double wrap being used at each end for extra strength. After wrapping, the casings are placed in a machine where mortise and tenon, or female and male joints are turned on the ends.

When wrapped and tenoned, the casing is taken to a machine where a thick coating of special waterproof asphaltum cement is given, and while still warm, a coating of sawdust rolled in, so that the casing can be handled without difficulty.

From a great many tests it has been determined that the best thickness of the shell is 4 in., and this is used as standard, although for low-pressure mains, a thickness of 3 in. or even 2 in. will serve. Casing made as above described has been found to reduce condensation and radiation losses to about ¼ of 1 per cent per mile of pipe, delivering its full capacity, and as a further means to reduce the radiation loss, a tin lining

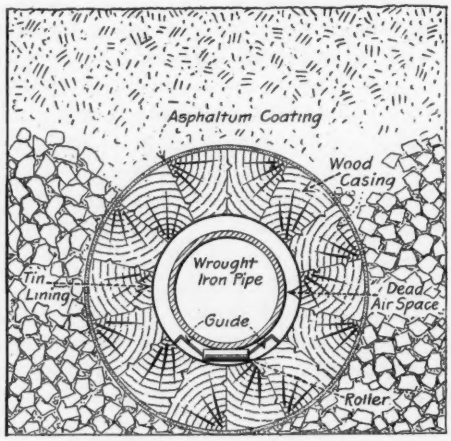


FIG. 4. PIPE AS INSTALLED IN TIN-LINED CASING

is used of the best grade of 4A charcoal tin, the tin lining being slightly smaller than the inside of the casing, and turned up at the end.

In laying the casing, the mortise and tenon joints are driven together, and where a change in direction is desired, a wood box elbow is furnished, as shown in Fig. 2. The mortise and tenon in the box connect to lengths of the casing, exactly as in the case of

joining 2 lengths, and the cover is then removed and the box filled with sawdust, or other loose insulation, around the pipe.

For holding the iron pipe concentric with the wood casing, pipe guides are used, as shown in the sectional view of the casing as installed. Joints between the sections, have the ends treated with a creosote preparation which is waterproof, so that there is no decay at the joint.

The Michigan Pipe Co. furnishes this casing in size for any pipe. Taps are easily made by stapling the wire on each side of the required space and cutting through the stave. The apparatus of the system includes boxes for covering tees and elbows, expansion joints and other special fittings.

THE MOLINE SYSTEM OF VAPOR HEATING

BRIEFLY described the Moline system which is especially adapted for exhaust steam heating, consists of especially constructed radiator supply and return valves that have no automatic parts. Restricter sleeves in the supply valves regulate the flow of steam to each unit of radiation to approximately what it should have.

The return valves are restricted in the same manner. The ports in the return valves are so proportioned that air and water flow readily from the radiators but so little steam will pass that it is quickly condensed in the return line.

The piping for this system is what is known as 2-pipe, with a separate supply and return connection to each radiator. The steam mains carry only the water from steam that condenses in them and the risers to the radiators.

The air and water returns take both air and water from the radiators.

The steam, and air and water returns, are run side by side in such a manner that the first radiator to receive steam is the last to have its air and water returned to the end of the air and water return main.

The steam main and the air and water return mains end at the same point and are there drained either to the boiler, if a low pressure boiler plant is being served, or to a device called a Moline seal if exhaust steam is being used.

A Moline ejector, condenser, radiator and air trap are the devices to get rid of the air from the systems and their combined operation is so effective that this is done continuously, automatically and without appreciable pressure. The condenser radiator may be either a coil or cast-iron radiator as the conditions on each installation require.

The ejector has no moving parts and is supplied from the end of the steam mains. It serves both to vent the steam main quickly and to draw the air from the air and water return main into the condenser.

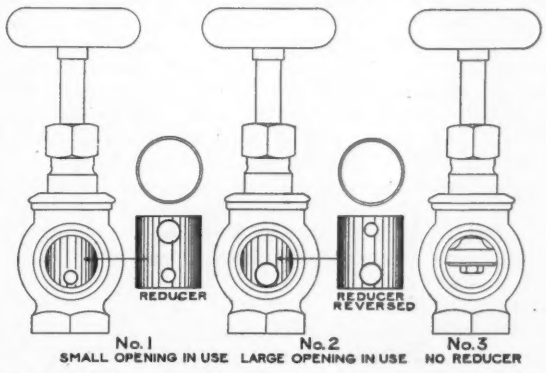


FIG. 1. SUPPLY VALVES AND RESTRICTERS USED IN MOLINE SYSTEM

The condenser condenses the steam that passes the ejector and its action combined with that of the ejector insures a rapid positive flow of steam through all the radiators.

The condenser is relieved of the condensation from the steam jet by a drip pipe back to the boiler or to a Moline seal as the case may be, and the air passes off through a Moline air trap.

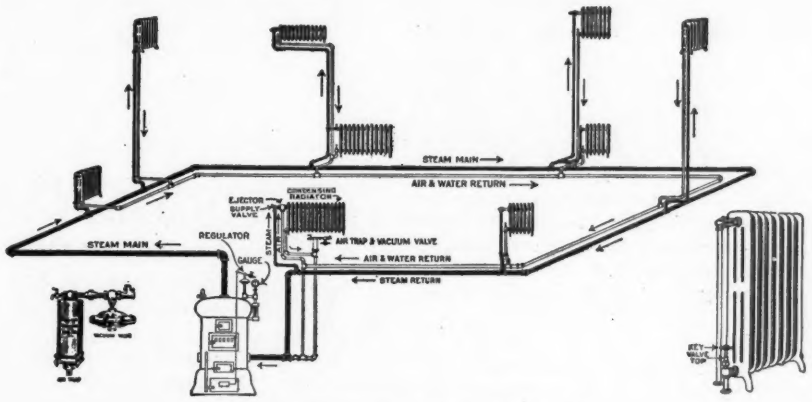


FIG. 2. DIAGRAM OF MOLINE SYSTEM

The Moline air trap is a big heat valve that leaves the system open to the atmosphere through the condenser until it is heated through and then closes automatically by the expansion of air in an open float, so steam cannot escape.

It will be noted that while the Moline system is a vapor system, pressure can be carried on it if necessary. A vacuum valve is put on the air trap if the Moline system is used on a low pressure boiler with a gravity return.

The Moline seal referred to performs the functions of a steam trap, yet it has no floats, valves nor moving parts to clog or require attention.

HORTON GAS ENGINE PACKING

JAMES Horton, the master mechanic of the Homestead Plant, of the Carnegie Steel Co., has in common with other engineers using double-acting gas engines of large power under hard service, had more or less trouble with the piston rod packing, and he has been compelled to give the packing question a great deal of thought. His investigations led him to bring out a packing that would overcome the common but serious fault of rapid reduction of piston rod and disintegration of packing segments. This packing is shown in the cuts and descriptive article below, and as it contains some novel features, we believe it will be of interest to our readers.

The main advantage of this improvement is to eliminate the excessive friction and wear on the piston rod, and it does this by preventing the closure of collapsible ring under excessive pressure. This is

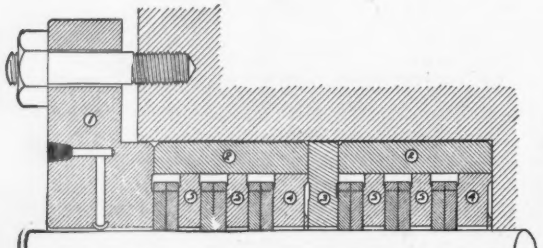


FIG. 1. CROSS-SECTION OF HORTON METALLIC PACKING

accomplished by construction as shown in Fig. 1, wherein the packing rings proper (Figs. 2 and 3) are shown in contact with the rod. They are placed in grooves, the walls of which (parts 4 and 5) are free to move in line with rod and thus to bind the packing rings against forcible closure at time of highest pressure in cylinder. In practice it is found that this side clamping of rings does not affect the sealing quality of the packing: as contact with rod is always sufficient to prevent passage of gases, but yet so light that wear cannot be detected on rods where this packing has been in continuous service for more than 2 yr. This record has been made on large engines operating under the most trying conditions.

The precentage of hydrogen in the fuel is at times greatly in excess of that which but a short time ago it was thought impossible to use without disaster to packing. It will be noted by observing cuts that rings and all corresponding parts of this packing are interchangeable with one another. This greatly adds to the simplicity, ease of handling and economy of operation, the advantage of which will be well understood by those who have had experience in this class of service.

This packing was designed and patented by James Horton, the efficiency engineer of the Homestead Plant of the Carnegie Steel Co., and is made to his design and formula by The Metallic Packing & Manufacturing Co., of Elyria, Ohio.

THE FULDA LIGHT AND POWER CO., of Pipestone, Minn., which lost its plant by fire recently, is making arrangements to have the plant rebuilt. Just before the fire a new lot of machinery was installed by the company and all the contents of the building were a total loss.

FLOORING FOR AN INDUSTRIAL PLANT

FLOORING the factory is a difficult problem, hence the flooring material known as J-M Mastic, made by the H. W. Johns-Manville Co., N. Y., is of interest. This flooring is noiseless, has a holding quality which avoids slipping, and is waterproof and unaffected by acids, alkali or brine. It can, therefore, be cleaned by flushing with water and will not originate dust.

The base is asphalt mastic which is bonded with asphaltic cement, the mineral material being passed through a wire screen, ranging from 80 to 200 mesh to the inch. The consistency may be made from extremely hard to soft, and will always have a certain amount of springiness to the step, so that it avoids foot weariness.

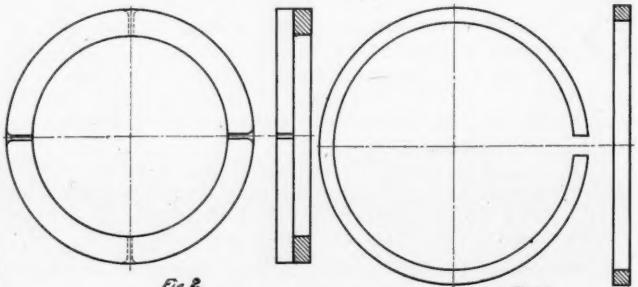


FIG. 2. PACKING RINGS WHICH FIT SHAFT
FIG. 3. OUTER OR SPRING PACKING RING

This flooring may be made over any firm foundation and can be applied on top of wood, brick, concrete or tile, but in a new construction, concrete or heavy mill construction is most desirable. The standard thickness is 1½ in., and the weight 18 lb. to the square foot. But for very light service, the thickness may be made 1 in., and for very heavy service, 3 in.

ALLIS-CHALMERS REORGANIZATION

ON April 16, 1913, Allis-Chalmers Manufacturing Co. took over the properties and entire operation of the business of Allis-Chalmers Co., which latter company during the past year has been in the hands of a receiver. This change marks the end of the Allis-Chalmers receivership and the conmmencement of the administration of the new company.

Beginning with April 16 all business has been and will be conducted by Allis-Chalmers Manufacturing Co., which starts out under conditions promising success. The new company will operate all departments of the business as conducted by its predecessor and will carry out all contracts on hand for the sale of its products. It has no bonded indebtedness nor liabilities of any character. In addition to all assets of the former Allis-Chalmers Co., the new company has over $4,000,000 additional cash for new working capital which has been raised through the recent reorganization.

The new company will continue to operate the large West Allis Works and Reliance Works at Milwaukee, the Chicago Works, and in addition will control the operations of The Bullock Electric Manufacturing Co.,

at Cincinnati. Otto H. Falk, of Milwaukee, who for the past year has been receiver of the Allis-Chalmers Co., and under whose management as receiver the operations of the business have shown marked improvement, has been elected president of the new company. The general offices will be at Milwaukee.

All properties of the new company are in good condition and its inventories and working capital on a sound basis. Its engineering departments are well equipped and the various lines of product now turned out are of the highest quality. Under these conditions it is believed that with the present careful and intelligent management the operations will show substantial profits.

SAMUEL L. MOYER

ON May 3, Mr. Moyer, First Vice President of The Lunkenheimer Co., passed away at his home in Cincinnati. He had been sick for a few days, and the night before became unconscious and, spite of every effort of the attending physician, he was not able to rally. The illness was due to gastritis, and Mr. Moyer had been south for some time in the hope of recovering, but was called back by the difficulties in connection with the recent floods.

Mr. Moyer was born in Cincinnati in 1874, son of Joseph Moyer, and received his education in the public schools and the Woodward High School. Graduating from the high school, he entered the works of The Lunkenheimer Co., and by industry and ability worked his way up to the management of that great institution. He had been honored with many city offices, always standing for public welfare and good government, and if he had regained his health, would probably have been the next Republican candidate for mayor of his home city.

He was generous, took a wholesome and lively interest in every phase of life, and was relied upon widely by those outside his own organization as well as by those inside. In his leisure hours he was a charming friend and companion, although feeling that life was a serious business, and that idling was not its purpose.

Five years ago Mr. Moyer was married to Miss Ella Hewetson, who with his mother, now 83 years old, and a sister, Mrs. R. D. Stoner, are the only near surviving relatives.

Mr. Moyer was a member of the American Society of Mechanical Engineers, took a leading part in the affairs of the National Metal Trades Association, and was prominent in the Queen City Club, the Business Men's Club and the Cuvier Press Club. He had attained high rank in the Masonic Order, and was also a member of the Elks, in which fraternity he was held in high regard.

NEWS NOTES

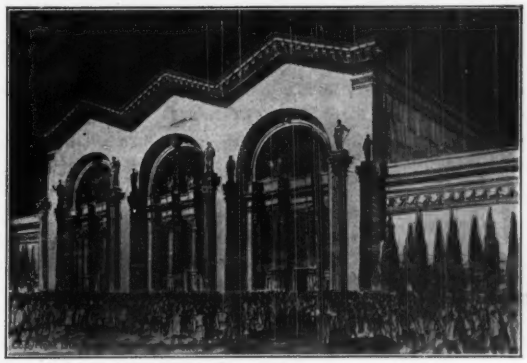
THE DIXIE POWER CO. is preparing for the construction of its hydro-electric plant on the White River in Baxter County, near Cotter, Ark., just as soon as Congress grants the necessary rights, the State rights having been obtained. Here 15,000 hp. can be generated, which will be available for the industries of central and northwestern Arkansas. It is estimated that the cost of constructing the entire plant ready for distributing electricity will be $2,000,000. Bankers and investors of the State of Arkansas will furnish the capital required.

THE HONORABLE WILLIAM C. REDFIELD, having been appointed a member of President Wilson's cabinet, has deemed it advisable to terminate his business connections. We have reluctantly accepted his resignation as a Vice-President and director and are compelled to announce his retirement from active participation in the management of this company. American Blower Company.

MAY 22 TO 24 the spring meeting of the Ohio Society of Engineers was held at Springfield, Ohio, at the Hotel Bookwalter. The papers on the program were "Repairs and Welds by Electricity," by E. C. Price; "Operating Characteristics of Transformers," by F. T. Wyman; "District Steam Heating with High Pressure Steam," by F. W. Ballard; "Foundry Experience on Semi-Steel Mixtures," by R. H. Probert.

Besides the technical discussions, there were inspection trips to the various manufacturing plants of Springfield, including the Lagonda Mfg. Co., Superior Gas Engine Co., Foos Gas Engine Co., Robbins & Myers Co., James Leffel Co., The Hoppes Mfg. Co., and the Springfield Light, Heat & Power Co.

MACHINERY HALL, the imposing facade of which is illustrated, will be the largest building at the Panama-Pacific Exposition, to be held at San Francisco in 1915. The building is now under construction and will cover



a ground area 368 by 968 ft. Its design is based upon the Roman Arch motif, with more than 1½ miles of ornamental cornices. Interior arrangement will have 3 naves 75 ft. in width, 122 ft. high and more than 900 ft. long.

THE PLATT IRON WORKS CO. makes the following statement concerning the damage done to its plant by the recent flood:

"While it is true we have suffered considerable damage, our buildings are practically uninjured and we have recovered more quickly than we anticipated. The second day after the water subsided we had steam up and the work of removing the mud and debris was started.

"Our entire organization responded most loyally towards getting the plant in operation, irrespective of the fact that many of them suffered personal loss due to the flood. A small portion of our plant was put in operation April 7, but due to the fact that a large number of our machine tools are equipped with individual motor drives we were obliged to bake and clean these motors and did not start up in all departments until April 21.

"We are now prepared to accept and fill all orders promptly."

BOOKS AND CATALOGS

WASTE OF NATURAL RESOURCES, as has been frequently stated in many ways, is one of the worst crimes of the American nation.

In a technical paper by Messrs. Arnold and Clapp, attention is called to the waste of natural gas and means to prevent it. Some history of the discovery of gas is given, and the waste due to the belief that gas supplies were inexhaustible, is shown. This waste at the present time comes largely from inexperience and inability to control the wells. Notably there are 2 wild wells in Louisiana which are not under control, and it has been estimated that the waste is 75,000,000 cu. ft. in 24 hr., a value of $2000 a day. In one of these, in February, 1912, there was a crater about an acre in extent, when visited by Mr. Clapp, where the gas was forcing a mass of mud and water at the center to a height of some 30 ft., and the well was burning much at the time.

The evil is not only to this well itself, but it decreases the pressure to the gas supply for all the wells in that district. This resource, like our coal and oil fields, is one which cannot be replaced, and it is most unfortunate that it should be wasted as is indicated in the pamphlet. Copies of the paper may be had by addressing the Director, Bureau of Mines, Washington, D. C.

THE WICKES vertical water-tube safety steam boiler is described in a series of illustrated folders recently issued by the Wickes Boiler Co., Saginaw, Mich.

WATERPROOF WOOD CASINGS for insulating underground steam pipes are described in an illustrated folder recently issued by the Michigan Pipe Co., of Bay City, Mich.

BULLETINS DESCRIPTIVE of Sims power plant appliances, including feed-water heaters, steam separators, exhaust heads, oil extractors, oil filters, etc., have recently been received. These appliances are manufactured by the Sims Co., Erie, Pa.

OF INTEREST TO EVERYONE who has to do with the problem of pavement, is a book issued by the American Steel & Wire Co., which is called Triangle Mesh Wire, reinforced Concrete Pavement and Roadways. This gives much information as to the cost of hauling material over different surfaces, the cost of construction for different styles of pavement, and the cost of keeping in repair. The comparison of values for different paving, considering the elements which go to make up the value as first cost, durability, ease of maintenance, ease of cleaning, low tractive resistance, non-slipperiness, favorableness to travel, and sanitary quality gives concrete as having 94 points out of a possible 100, with asphalt block as 79.5 and creosoted wood block as 80. In connection with the matter of concrete, the subject of reinforcing concrete is taken up, and examples are given of the increased durability and low upkeep due to such reinforcing. It is shown that a high quality of pavement with the best material can be laid at an average price of $1.10 to $1.25 per square yard, that the surface remains smooth and does not settle into holes or dig out into pits.

The exact method for laying such pavement is described, and estimates are given of the amount of material needed, the amount of crowning desirable, provision for expansion and other data of interest.

PRACTICAL ENGINEER

Trade-mark reg. U. S. Pat. Office.

SEMI-MONTHLY

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Positions Wanted

POSITION WANTED—AS ENGINEER or switch-board operator in large station. Nine years' experience, engines, boilers, turbines. A. & D. C. currents. Well up in modern plant methods. Total abstainer. N. E. C., No. 8 Arlington Ave., Morganstown, W. Va. 6-1-1

POSITION WANTED—Electrical Engineer wants to locate with some reliable isolated plant in Public Service plant, nine years' experience at estimating, constructing and mining plants. Can give best of references as to ability and habits. Chas. Thomas, Jr., Box 464, Aurora, Ind. 6-1-1

Wanted

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IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED EVERY ENGINEER to have our pamphlet for setting valves on Corliss Engines, simple and compound, with one or two eccentrics. Sent free. Lindstrom's Machine Works, 200 South Third St., Allentown, Pa. tf.

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DETROIT MANUFACTURERS of Boiler Specialties have an opening for a sober, aggressive type of engineer who thinks he would make a good salesman. We want a man of good appearance, a good talker, with a wide acquaintance among engineers in your territory. This is an unusual opportunity for a permanent connection with an old established business, on a very attractive basis. Address, Box 305, Practical Engineer, Chicago, Ill. 5-15-3

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For Sale

FOR SALE—"WATERTOWN" MILL FRAME, side crank, horizontal Steam Engine, 18x28 in. cylinder, only 6 years old, wheel 12 ft. by 24 in., guaranteed perfect, price $750. Also 1 150 and 1 175-hp. Manning Boilers, $950, and 2 150-hp. horizontal, return tubular Boilers, good for 125 lbs. steam, $800. J. F. Foster, 166 Devonshire St., Boston Mass. 6-1-2

FOR SALE—A double tandem automatic gas engine, 250 H.P. on natural gas, or 200 H.P. on producer gas. We are prepared to offer a great bargain. Phoenix Iron Works Co., Meadville, Pa. 5-15-3

OIL ENGINE MANUFACTURERS note this! For Sale, design for a spray nozzle for oil engines. Can be adjusted while engine running. Will handle all grades of oil. J. D. Kiser, 1374 East Ave., Elyria, O. 6-1-1

FOR SALE—ONE ENGINE-GENERATOR Unit consisting of Russell simple, high speed, single valve, enclosed engine, direct connected to 75-KW., 110-volt, direct-current Crocker-Wheeler Generator. In excellent condition. Immediate delivery. For full particulars address the Griscom-Russell Company, 2141 West Street Bldg., New York. 6-1-1

FOR SALE—14-32 Watts Campbell Corliss engine, seen running until May 1st; condition like new, $600. Duzets & Son, 40 Church St., New York. tf.

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PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owens, 28 Owens Bldg., Washington, D. C. tf.

FIND OUT FOR YOURSELF what to invent and how to procure and sell a patent for the same. My book, "Inventor's Universal Educator," covers the matter from A to Z. 140 pages, elegantly bound. Also contains 600 mechanical movements and 50 perpetual motions. Price $1.00, postage free. Money returned if not more than satisfactory. F. G. Dieterich, 618 Ouray Bldg., Washington, D. C. 6-1-1

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LAWRENCE J. GALLAGHER, formerly assistant examiner United States Patent Office; solicitor of patents. 2 Rector St., New York. 5-15-3

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"PATENT PROFIT from Patton Service," is the title of our instructive booklet for inventors; sent free upon request. Strong patents that legally protect are our specialty. Send sketch or model today. Harry Patton Co., 330 McGill Bldg., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. tf.

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MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you how. tf.

Sparks From The Advertising Pages

Let's be reminiscent today. Sort o' draw up our chairs by the fire, light our pipes, and ramblingly talk over "old times" in advertising.

* * * *

It's funny how the entire spirit of advertising has changed within the last century. This thought struck home, hard, to us a few weeks ago down at Washington, D. C. In common with every other tourist who visits the Governmental City, we "rubbered" through the Congressional Library, and looked over some of the newspapers of the early 18th Century. Naturally, what interested us most were the advertisements. And, we noticed that the greater number of them were "Reward For Runaway Slave" notices of the want-ad type.

A few minutes later when in a street car on the way to our hotel, we observed in front of us a colored man, reading a newspaper advertisement of a season's clothing sale. *The Advertising of Today is TO instead of FOR These People.*

* * * *

During the decades immediately before and after the Civil War, the magazines carried a great deal of Patent Medicine advertising. Some of us can remember how these manufacturers "whooped her up." To them, advertising was simply a noise and a bang;—"Shout your name from the housetops." They claimed everything. Truth went to the discards. As one wit aptly described a certain manufacturer's policy, "A dose of his wonderful elixir makes an octogenarian cry for his marbles."

But, how the mighty have fallen. *Today, the reputable magazines refuse to print patent medicine advertising.*

* * * *

Newspaper comment on the recent bill passed by the California Legislature brings to our mind the statement of Prof. Ernest W. Clement of the Unversity of Tokio, in an article published in the November issue of the Biblical World. According to his observation, the introduction of our Bible and religious hymns into Japan has brought about some very ludicrous occurrences. The tunes of the hymns strike the popular chord so well that the Japanese merchants employ bands of performers, who dress in grotesque costumes and march through the streets advertising tea, rice, dried fish, etc., to the tune of "Rock of Ages," or "Nearer My God to Thee." To make matters worse, the performers do acrobatic tricks to the tune of the hymn. Which leads us to opine that if Ringling Brothers' Circus would travel Japan it would become a wonderful advertising medium.

* * * *

Old Josh Billings wrote some mighty good things in his homely philosophical maxims. He said in one of them: "I luv the rooster fer tew things. One iz hiz krow and the uther iz the spurs that he backs up hiz krow with." It is a fine simile to apply to present day advertising. *The CROW of the advertiser must be backed up by the spurs of MAKE GOOD.*

Deception and extravagance are no longer a part of advertising. Even, with the circus, it is now an uncommon occurrence to hear the one-time familiar plea: "They haven't got half what they advertised." The trend among the advertisers, themselves, is toward a national law for pure advertising. The states of Ohio, Washington, Minnesota, North Dakota, New Jersey and Nebraska now have laws against extravagant claims in advertisements.

* * *

It is with pardonable pride that Practical Engineer refers to the high class of the advertisements in its pages. Its Advertisers welcome a thorough investigation of their product, either by *actual trial* or by *more information.* They appeal to your common sense. They tell you *why.* They prefer to get your trade through *proof,* rather than through *misrepresentation.*

You should read the advertising pages of Practical Engineer EVERY ISSUE. The manufacturers have new things to say to you. If your power plant needs any kind of machinery or supplies you will find it advertised there.